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ABSTRACT

Based on criteria that were developed for the design and evaluation of undergraduate level programs in construction, a model of a four-year, 132 semester credit program is presented. Major academic requirements consist of 15-21 credit hours of each of the following: mathematics and science, communication skills, construction engineering, construction technology, construction mangement, and business administration. Nonacademic components include formation of an industry advisory committee, establishment of student organizations, career counseling processes, and faculty selection. Recommendations for a model curriculum were derived from literature surveys, analysis of existing programs, accreditation requirements, and consultations with educators and practitioners. The goal is preparation of students for entry level positions in the production side of the construction industry. Selected studies and papers on construction education completed prior to 1976 are summarized, and an overview of a study (HE 013 346) that explored perceptions of experienced constructors regarding elements of Associated General Contractors guidelines is presented. A quantitative analysis of selected curricula and a descriptive listing of professional and industrial associations that are involved in accreditation are appended. An abstract of a research study on analyzing construction curricular elements and a bibliography are included. (SW)

CRITERIA FOR DEVELOPMENT OF BACCALAUREATE LEVEL CONSTRUCTION CURRICULA

A Resource and

Planning Guide

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NATIONAL SCIENCE FOUNDATION PROJECT SED76-18870

Technical Report Published August 1977,
Construction Curricula Planning and Resource Guide
January 1979

THIS GUIDE IS FOR:

. . . . . the new construction educator, for those planning a new construction program, and for the construction practitioner involved in construction education on the campus or in the industry association.

This Guide was prepared with the support of National Science Foundation Grant No. SED 76-18870. The opinions, findings, conclusions and recommendations expressed herein are those of the Project Staff, and do not necessarily reflect the views of NSF.

"Three things are to be looked to in a building:

that it stands on the right spot;

that it be securely founded;

that it be successfully executed."

Göthe

ACKNOWLEDGEMENTS

The investigator wishes to recognize and thank the education committees of the Associated Schools of Construction, the Associated General Contractors and the American Institute of Constructors for allowing participation in the many discussions concerning philosophy, direction and content of construction education.

It is not possible to recognize each of the education committee members of the several organizations, however, several have contributed generously to the development of this project: Mr. Robert N. Olsen, Constructor, Indianapolis; Mr. Duke Nielsen, AGC staff member, Colorado; Dr. James Snyder, Construction education, Purdue; Dean Jerry McClindon, Louisiana State University; Mr. Ralph Korte, Construction, Highland, Illinois; Dr. Don Martin, Professor Ken Ricard, Construction educators, Colorado State University and Professor Wesley Baldwin, University of Southern Mississippi.

Resource materials, pertinent data and constructive recommendations were furnished by many other persons - educators and practitioners. To these persons - thank you. The investigator is grateful for the dedicated assistance during the project by the departmental secretaries - Cathy Broome and Ann Poole.

As a relatively new construction educator, Co-investigator David Marchman, gave a professional perspective to the project.

Many thanks also goes to my family for their patience during the numerous trips and weekends spent away from home.

James W. Young, Ed.D, AIC

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PREFACE

Over the past two decades, construction has emerged as a unique academic discipline, strongly supported by industry and reluctantly accepted by much of academia. This evolvement has neither been rapid nor without trauma. However, the "Constructor" graduate is now a product of over 75 baccalaureate degree programs. Unfortunately, this explosion of new programs has not brought with it a uniformity in curriculum organization or content. Such variance can be observed in the differing levels of academic rigor and divergent background of faculty, in both education and experience.

Construction is an everchanging industry. New approaches to construction must also be integrated into the educational process for the student to be reasonably current. This means curriculum content should be continuously re-evaluated; faculty must be up-dated, and new faculty selected for both appropriate educational degrees and relevant, current experience.

However, construction as an academic discipline remains in a state of evolution. So recent is the development of construction education, that, at the time of this project, no doctoral programs existed to provide advanced education in construction, as an extension of an undergraduate level program in construction. The academic world which requires doctoral degrees for university conformity, comes in conflict with the construction world which is practical and essentially experience oriented.

The guide was developed in an attempt to synthesize various formal and informal curriculum research efforts, including the technical report on analysis of construction curricular elements, produced by this investigation.

The technical report was developed to further refine and reevaluate the recommendations of a contractor organization for construction education, with particular emphasis on production management personnel as opposed to executive level management. Data from the technical report were used as a comparative model for the recommended curriculum in the resource guide.

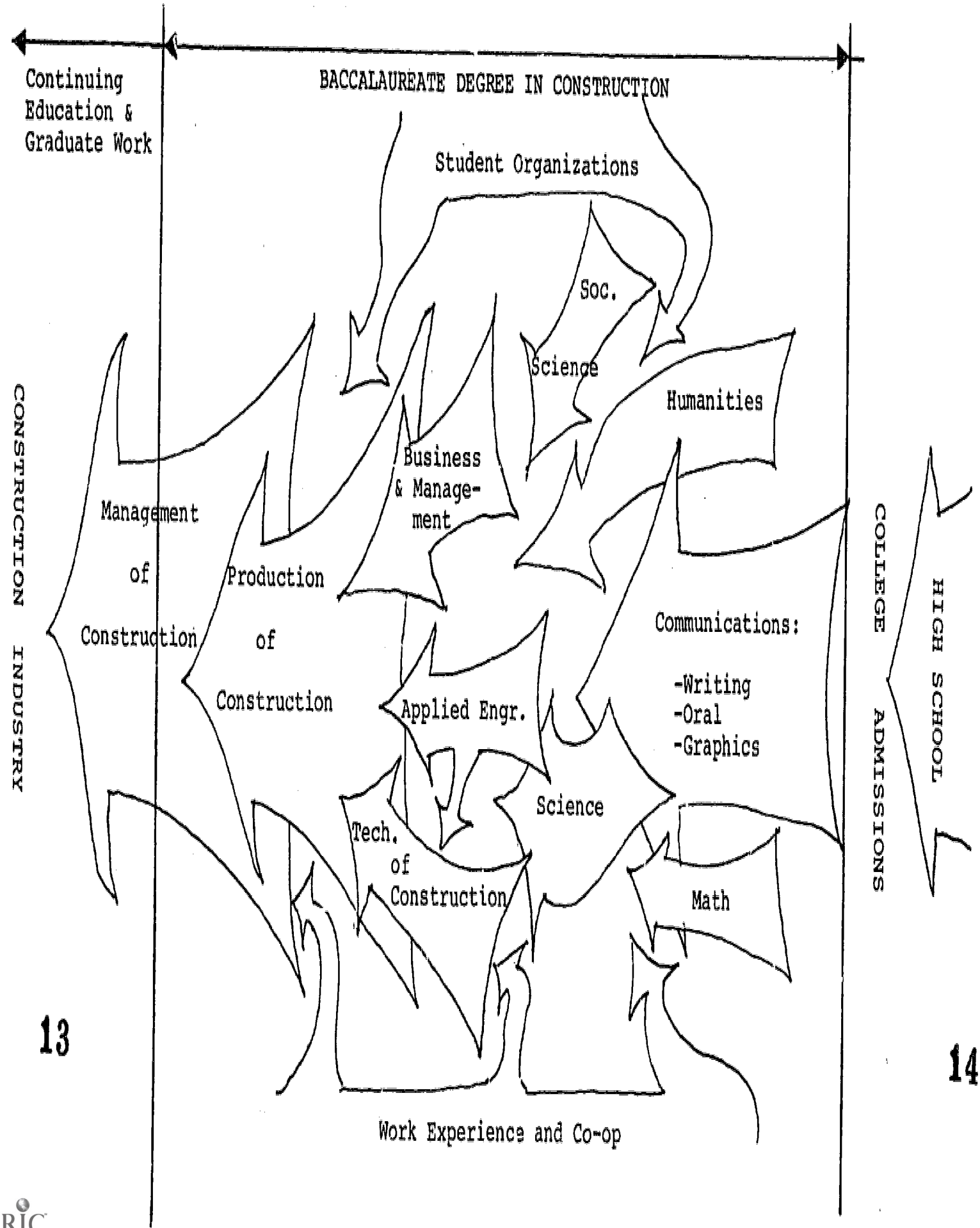
For those educators and practitioners charged with the responsibility of developing and implementing a new construction curriculum, this guide represents the collective thought of many persons and associations. For the new educator in construction, this guide and technical report will provide a historical and philosophical background on the status of

construction education and related curricular research.

Further background in the development of new technology programs may also be obtained from the National Science Publication "Get Them Underway", Dr. Kenneth Woolf, Project Director.

The broad spectrum of construction operations and management preclude a single curriculum to meet all needs. Flexibility is encouraged, assuming a strong, rigorous academic base. These recommendations in no way intend to inhibit the creative development of new curriculum concepts, but in fact, intend that it be used as an additional component of the construction education structure.

EDUCATION FOR THE PROFESSIONAL CONSTRUCTOR


COMPONENTS OF CONSTRUCTION EDUCATION
Continuing Education & Graduate Work
BACCALAUREATE DEGREE IN CONSTRUCTION
Student Organizations
Soc. Science
Humanities
Business & Management
Management of Construction
Production of Construction
Communications:
-Writing
-Oral
-Graphics
Applied Engr.
Science
Tech. of Construction
Math
CONSTRUCTION INDUSTRY
COLLEGE ADMISSIONS
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PART I: NARRATIVE

A. Project Goals

The primary objective of this project was to develop criteria for construction education curricula at the baccalaureate level based on the input of industry practitioner and construction educator. Concurrent objectives also included:

(a) The analysis of differences in construction curriculum elements as recommended by a national contractor organization education committee, with respect to educational background and work experience of project oriented practitioners.

(b) The synthesis of previous informal and formal curriculum research with the findings of the technical report.

(c) The development of a construction curriculum model based on the production processes of construction as an initial career objective, with academic preparation for construction management.

(d) To make available in one resource the related data and recommendations for the development of a viable construction program.

B. Rationale

The contribution and interrelationship of the construction industry to the national economy is well documented, and is readily apparent in our everyday lives. Less visible and even less understood is the scope of the process and nature of the persons managing the construction process. Not identified as a "professional", as is the Architect or Engineer, the contractor never-the-less assumes a responsible position on the construction team. It is the Constructor who provides real direction to the construction process, accepts a genuine responsibility for quality work, completed on time and for agreed prices. The by-laws of the American Institute of Constructor state "the Constructor possesses skills founded on systematic knowledge acquired through prescribed education and refined by experience".[1]

Over the past two decades, the industry has adopted radical changes in construction methodology, contractual systems and managerial control systems. The industry continues to evolve toward the concept of "comprehensive professional services".

Projecting the need for new concepts in educational background for field production and management personnel in construction, a major industry association developed and

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[1]Official Register, The American Institute of Constructors, Oklahoma City, Oklahoma. 1977-78, p. 5.

distributed recommended curricula in the mid-1960's. While several baccalaureate construction programs were in operation, little consistency was apparent in programs until after 1965. Degree titles, university program location and academic level were developed within local parameters and not in conjunction with national direction.

Associated Schools of Construction (ASC)

The organization of the Associated Schools of Construction in 1965 lent direction to communication between the existing construction curricula. Concurrent with movement of ASC, the AGC distributed their curricula recommendation. In the late 1960's and early 1970's, some 30-35 new construction programs were implemented. Even with the general lack of uniformity or quality of graduates, the number of construction graduates could not begin to meet the demand placed on the institutions by industry.

American Council for Construction Education

Through efforts of the ASC, the American Institute of Constructors (AIC), and several major industry associations, the ACCE was organized to exercise leadership in assuring the general public and the industry of the stature and quality of construction graduates.

Current accreditation standards by ACCE do not require total conformity to a single curriculum model but instead assume each program will develop its own guidelines and emphasis within parameters and objectives of ACCE. Flexi-

bility in curriculum planning and creative approaches to construction education are encouraged by ACCE as overall quality of program is maintained and is directed toward a professional concept of construction education.

In the development of curricula standards, ACCE utilized input from ASC and AIC, and the guidelines produced by AGC. While the AGC guidelines were tempered with experience in education, no further research was conducted to validate the guidelines after a 10 year period of use. This then formed the basis of the technical report. The data are evaluated and element priorities shown in the technical report.

Up to the time of this resource guide, no published materials existed which attempted to combine curricula recommendations with information on other aspects of program developments. This resource guide is not to be used as an accreditation guide, although many recommendations do meet the minimum standards of ACCE.

ASSOCIATED GENERAL CONTRACTORS EDUCATIONAL GUIDELINES

This investigation further develops the guidelines as proposed by the AGC Education Committee and determines by statistical analysis the validity of those curriculum elements as perceived by experienced constructors with a project orientation as compared to the industry executives who originally developed the guidelines. The investigation was concerned with educational backgrounds of constructors

and their perceptions of the relative importance of the curricula elements in the recommended guidelines. These results are given in full detail in the technical report and summarized in Part II of this guide.

To further document perceptions of the industry practitioner and educator toward a construction curriculum, the investigation includes data from several unpublished studies. Over the period of the project, education committee meetings of AGC, AIC, and ASC have been monitored for additional comments and consensus on major curriculum philosophy. While not purporting to represent all segments of the industry, the investigator feels the resource guide represents a reasonable consensus of current thought on construction education.

Much of the curriculum content relevant to construction is conceptually based on functions of the commercial building process, including methods and management. It is recognized that residential construction or mechanical, may involve different methods of construction or managerial procedures. However, all areas of construction appear to have common concepts in a manner similar to engineering. Where appropriate as determined by program goals, local industry needs, or faculty expertise, additional courses or concepts may "packaged" to meet those needs.

As in other technical disciplines rooted in the fundamental concepts pertinent to that discipline, graduates

will assume responsibility in all areas of the industry or profession. Construction graduates known to the investigator (over 500), are in every type of construction existing and perform with acceptance and credibility. The quantitative values given to elements are based on a review of current university catalogs, and are intended to serve as a relative value. Traditional academic courses such as english composition, mathematics and the sciences, are shown in typical semester credits. Non-traditional courses in areas of construction are shown as sub-elements, or concepts, with a composite value of semester credits for a given group or component. These sub-elements (or concepts) may be "packaged" as time, faculty expertise or program goals may dictate.

The recommended criteria for a construction curriculum fall in the spectrum of the construction process referred to as the "production" of construction. This typically becomes the career entry position but does not presume to classify this constructor grad as only capable of the production responsibility. Further training, maturity of individual and additional education, basic aptitudes and opportunity, may all contribute to that person's movement into the concept of total professional construction management services. Certainly the educational base must be solid, rigorous and demanding. The success and growth of the graduate, however, may well depend more on his own aggressiveness, drive and personal motivation.

C. Current Status of Construction Education

When compared to 10 or 15 years ago, the current status of construction education shows tremendous ground gained, but still short of full academic acceptance, uniformity and respectability as a profession. On the positive side:

(a) American Council for Construction Education is accrediting construction programs.

(b) Several programs have moved from department level status to "Schools of Construction".

(c) Numerous programs have had over 300 students enrolled in construction.

(d) Job offers to graduates exceed supply, with current national job offers well above $15000/year.

(e) The Associated Schools of Construction are beginning discussions on the taxonomy of construction education.

(f) At least nine major industry associations are participating in the accreditation process.

(g) Advertising in construction periodicals now recognize the "Constructor".

(h) New programs continue to emerge each year.

On the negative side:

(a) While the product of a construction program has been identified as a "Constructor", few programs have common titles. Such inconsistency

presents a less than unified picture of construction education.

(b) Lack of qualified academic instructors will probably reach a critical stage in a few years. Instructors for mechanical and electrical systems are almost non-existent. University salary structure and promotion procedures are non-competitive with industry opportunities.

(c) No doctoral level program is in operation as an extension of an undergraduate construction curriculum.

(d) Construction education continues to fight for identity in the university structure.

(e) Considerable time will elapse before accreditation will have a major effect on program inadequacies, and really assist in developing a unified approach to construction education.

D. Definitions

Communication implies understanding between the communicator and receiver. To aid in his process, the following terms were defined by several associations.

The following definitions were developed by the Associated Schools of Construction:

Construction: The act of producing a structural entity from engineering or architectural design, where such entity is fixed in location and is of sufficient magnitude to require organization of men and equipment for its assembly at the final site.

Construction Management: The process of marshalling money, men, materials and equipment against time, weather and human nature to accomplish the act of construction.

Construction Science: Systematic knowledge underlying the act of construction without excluding familiarity with the processes of design.

The following definition appears in the By-Laws of the American Institute of Constructors:

Constructor: Responsible master of that discipline which comprises the whole of the construction process as well as the essential parts thereof, processing such skills founded on systematic knowledge acquired through prescribed education and refined by experience, or earned equivalently as a recognized practitioner, who initiates, develops, produces, delivers and services in whole or essential part construction works at prices, times and standards of quality which assure advantage to clients and society as a whole.

Systems Analysis and Curriculum Study

To assist in the process of analyzing and discussing curriculum description, the investigator has attempted to translate several educational terms into the terminology of

industrialized building. There may be unanswered philosophical questions appropriate to this analogy, however the investigator found the terms easily adapted to this project.

1. Concepts and skills ..... are..... sub-elements

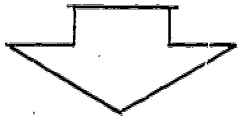
Basic body of knowledge, identifiable as a single unit.

A concept or skill, identified as the smallest teachable unit.

2. Courses.....are..... elements

organized group of concepts or skills packaged by meaningful relationships

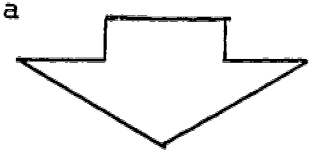
Organized group of sub-elements contributing to recognized objective, and to which credit hours have been assigned



3. Curriculum Divisions.....are.....components

group of courses constituting an area of specialization

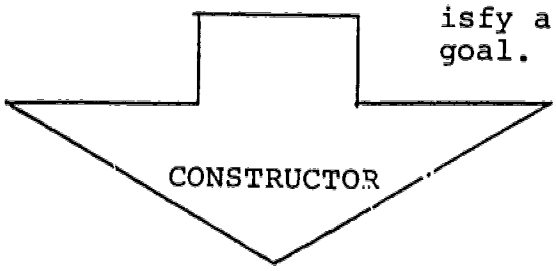
A group of elements grouped by meaningful interrelationships



4. Curricula.....are.....systems

organized group of courses which accomplish predetermined objectives

A set of interrelated and coordinated parts which function as a total entity to satisfy a specialized goal.



PART II: STUDIES IN CONSTRUCTION EDUCATION

Introduction

Construction education is a response to industry needs, expressed by industry leaders and educators over a period of several decades. Informal studies and published articles have pointed out the unique educational needs of construction. However, in many cases, the dissemination of information did not match the importance of the data. While several surveys indicated educational needs as early as 1961, no further formal curriculum studies were produced until the mid-1970's.

The purpose of Part II is to summarize selected studies and papers on construction education completed prior to 1976. The technical report is also summarized and a quantitative analysis of selected curricula is presented. Data relevant to the development of current curriculum needs will be discussed.

A: Studies and Papers on Construction Education to 1977.

The formal and informal studies and papers annotated in this section were selected to illustrate the trends not only toward specific construction courses in a curriculum, but also toward a separate discipline in construction. As appropriate, practitioner input is described and highest priority needs listed.

(1) 1951 F. H. Kellogg - University of Mississippi
"The Construction Curriculum in Civil Engineering," Civil Engineering Bulletin, February, 1951.

A civil engineer, Professor Kellogg suggested that senior engineering design courses be replaced with specific construction subjects, to prepare graduates in engineering to be more than engineering technicians in construction.

(2) 1956 W. A. Klinger, Contractor - Sioux City, Iowa
"Construction Education: Industry Leader Proposes 5-Year College Curriculum," The Constructor, January, 1956.

Mr. Klinger, a former president of the AGC and active proponent of education for construction, recommended a 5th year of construction management courses be added to a regular civil engineering program. In 1961, as chairman of the AGC Education Committee, Klinger reported that construction was changing but education for construction had not changed. Results of a survey sponsored by AGC contractors indicated an overwhelming desire for construction management courses within the civil engineering program, even if advanced design courses were omitted. Construction is essentially a management function.

The survey ranked the following construction subjects:

(1) Construction estimating & costs
(2) Construction job planning
(3) Contracts & specifications
(4) Construction materials
(5) Soil mechanics, earthwork & foundation
(6) Site layout & development
(7) Formwork design

Management subjects were ranked in the AGC survey as follows:

(1) Estimating & cost accounting
(2) Labor - management relations & labor law
(3) Accounting
(4) Economics
(5) Business reports & public speaking
(6) Banking & corporation finance
(7) Real estate & engineering law

(3) 1960 Dean David A. Day - University of Denver ASEE-AGC Survey of Construction Education 1959-1960, Joint Cooperative Committee, American Society of Civil Engineers & Associated General Contractors

Professor Day, under the sponsorship of AGC-ASCE Joint Committee, conducted a survey of all accredited programs in engineering and architecture. The purpose was to determine the extent to which colleges are offering construction related courses.

Survey results indicated the majority of Civil Engineering curricula and all of the Architectural Engineering curricula had at least some construction course work. Of the course work reported, contracts and specifications, estimating, construction equipment, engineering economy, building construction and materials were listed with the greatest frequency.

(4) 1966 Dean David A. Day, University of Denver Curricula Which Will Develop Professional Staff Needs of the Construction Industry. Paper presented to American Society of Engineering Education annual meeting, June, 1966, Washington State University.

A discussion of historical background of engineers in construction. Criteria appropriate to inclusion of construction in an engineering degree program. Dean Day encouraged the inclusion of at least one standardized construc-

tion course in civil engineering. Some consistency in academic preparation is encouraged in the educational introduction to the construction industry. Specialized courses are suggested as a means to orient a business major into construction.

The content of this specialized construction course would include:

(1) Construction organization and labor relations
(2) Construction equipment
(3) Estimating-quantity surveys, productivities
(4) Financing construction, cost accounting
(5) Construction management-methods, CPM and principles of administration

(5) 1967 Construction Curricula Study
Curriculum Study Committee,
Frank Orr, Chairman
Asscciated Schools of Construction

The survey questionnaire was sent to 24 schools, requesting courses be divided into six categories for analysis of curriculum content. The distribution of coursework by percentages is shown in Table I , with a comparison to present day ACCE requirements. Component titles are slightly different so the comparison will not be precise.

TABLE I

COMPARISON OF 1967 ASC CURRICULUM COMPONENT PERCENTAGES TO 1978 ACCE CURRICULUM STANDARDS

ASC Components	1967	1978	ACCE Components
Basic Sciences	18	15	Basic Sciences
Applied Sciences	22	17.5	Fund. of Const. & Structural
Management	24	32.5	Basic Administration Const. Management
Humanities	20	12.5	General Education
Complement. Adjuncts	10	12.5	Construction Methods
Electives	6	10	Program options
	100%	100%	

(6) 1972 . Associated Schools of Construction
An attitude survey of ASC member schools on accreditation.

A survey of ASC members, with 18 schools responding on attitudes to accreditation of construction curricula. Program emphasis was surveyed, ed.: technical versus professional management, and the content values of math and science and other components reviewed.

Only two of the 18 schools did not feel accreditation was valuable to status of education. Opinion was in the majority that no differences should exist between technical and professional curricula. Differences between the two curricula were found in the level of math and science and pro-

duction of construction aspects as compared to more theoretical levels of management.

Participants ranked the following curriculum content factors:

(1) Managerial knowledge
(2) Intellectual discipline
(3) Problem solving
(4) Human factors
(5) Communication skills
(6) Curriculum quality

In comparison, practitioners ranked communication skills above all other elements in the majority of surveys. Managerial knowledge ranked below some types of technical skills. The majority of participants agreed with the AGC curriculum recommendations.

(7) 1972 Paul W. Scheele, Chairman Indianapolis
Joint University-Industry Committee on Construction Education
Purdue University, 1972.
Dorsey D. Moss, Secretary

Recommendations developed by a joint academic-industry committee established to study construction curriculum needs at Purdue University. Three different curricula were proposed, essentially emphasizing a broad based construction curricula, an emphasis in engineering, and a composite program, emphasizing a strong management influence.

Industry committee members also recommended:

(1) a graduate should have completed three summers of construction work experience before graduation.

(2) The percentage of credit hours between areas of science, engineering, construction, management, and general education should be essentially balanced.

(3) A strong preference was given for a School of Construction.

(4) The program should be designed for students with aptitudes comparable to those of engineering and industrial management.

(5) Academic topics receiving a ranking of greater than 50% in a committee member evaluation are as follows:

Basic Sciences

Algebra & trigonometry	16	(of 18 possible pts)
Computer programming	15	
Analytic geometry	15	
Statistics	10	
Physics	9	
Drafting fundamentals	9	

Engineering and Design

Engineering economy & Cost analysis	11	
Surveying fundamentals	9	

Construction

Cost estimating & bidding	11	(of 12 possible pts)
Const. economics & cost control	11	
Plan reading	10	
Contracts & Specifications	10	
Contractors organization	10	
Project organization	10	
Work experience	10	
Actual construction projects	9	

Management

Cost accounting	11	(of 12 possible pts)
Finance, insurance, taxes	10	

Accounting	9
Supervision	9
Socio-Humanistic	
Speech	10
English	9

(8) 1974 Survey of Contractor Educational Needs Joint project of AGC Education Committee and the Department of Civil Engineering, Clemson University.

The study involved a survey of national AGC contractors, local contractors and AGC chapter managers who ranked 38 items concerning educational needs at all levels. With 253 responses from national AGC contractors and on a seven point scale (-3 to +3) items closely related to project management were ranked as follows:

1.	Getting people to work efficiently	2.70
2.	Planning a project (superintendent level)	2.57
3.	Planning and managing a project	2.48
4.	Managing people (superintendent level)	2.46
5.5.	Managing people	2.43
5.5.	Cost control (superintendent level)	2.43
7.	Interpreting plans and specifications	2.32
8.	Relationships with subcontractors	2.30

Working with people and planning work apparently are areas of concern where contractors feel education may improve effectiveness of industry management.

(9) 1975 Arthur W. Grossman, California State University-Long Beach
Importance and Proficiency of Construction Technology Competency Elements. Unpublished Ph.D. dissertation, University of Missouri-Columbia, 1975.

Professor Grossman surveyed graduates of the Industrial Technology program and their respective employers, and also instructors of construction technology. Participants were asked to rank competency elements on a six-point scale for Level of Importance and Level of Proficiency. The 113 competency elements were grouped into five component groups: management sciences, basic sciences, basic and applied engineering, construction management and technical construction.

Conclusions reached by the study indicated a significant correlation between Level of Importance and Level of Proficiency elements as ranked by the three groups. A rank order of Competency Elements by Level of Importance is shown in Appendix A . Selection of elements were oriented to entry level competencies for a construction technologist.

A strong similarity existed between the highest ranking of elements in the study by Grossman and by the informal study by Flaherty.

(10) 1977 James A. Roger, California State Polytechnic University
A Comparative Study of Construction Curricula in the United States. Unpublished Masters' thesis, University of Florida, 1977.

The current status of two and four-year construction programs were evaluated, with an attempt to determine how well these programs are supplying the needs of the construction industry. Conclusions reached included:

1. There are more than 83 different four and five year construction programs.

2. Even with diversity of programs, a trend was indicated toward meeting of ACCE or ECPD accreditation criteria.

3. Programs classified as "Construction" show a tendency toward a more balanced program of components, as set forth by ACCE.

4. Industry Advisory Committees were recommended.

Roger found that construction programs had a greater percentage of curriculum elements classified as fundamentals of construction and engineering than required by ACCE and with fewer electives than ACCE recommends. Programs categorized as "construction" had an average of 18% of the curriculum in construction administration. Engineering programs of construction had an average of 14% in the same component.

(11) 1977 Marvin J. Flaherty University of Washington Curriculum Education Study, unpublished informal study, University of Washington, 1977.

A survey of alumni, local and national contractors and related business on the level of importance of 70 elements. Elements were grouped by project generation, office management, field management, or related engineering elements. The results were used as input to improve the curriculum in Building Construction at the University of Washington. A rank order of responses by national contractors is given in Appendix B.

Alumni and contractor groups ranked written and oral communications highest, with estimating and quantity take-off ranked second. Cost control methods and supervision ranked in the upper ten percent of the element ranking.

B. Technical Report Summary[1]

During a decade of curriculum development and teaching, the investigator used as a planning guide AGC construction education curricular recommendations. Formulated by management level construction practitioners in committee action, the guidelines were used until 1976 without further evaluation.

The purpose of this study was to explore perceptions of experienced constructors regarding elements of the AGC guidelines. More specifically, the study was designed to answer the following questions:

(1) What level of importance do selected experienced constructors place on each of the elements listed in the curricular guide?

(2) Are curricular elements listed which present day constructors feel should be obtained from sources other than an undergraduate program in construction?

(3) Are curricular elements identified as essential to undergraduate curricula that were not included in the original guidelines?

(4) Does the academic background or length of construction experience influence the perceptions of experienced constructors toward the construction curricula elements of an undergraduate program?

Limitations of the study included:

(1) Participants were selected from member construction firms of AGC chapters located in Colorado.

(2) Participants were selected from staff and salaried positions with primary responsibilities in field operations and office technical and management functions. The highest level of responsibility of a participant selected for this study was that of Project Manger.

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[1]Refer to Appendix G.

(3) Only persons with college degrees and a minimum of one year of construction experience after graduation qualified as participants.

Study Population

Employees of member firms of the two AGC chapters of Colorado were used as a population base of 125 experienced constructors, from which 63 responded to the survey instrument. These responses came from 35% of the 96 construction firms contacted.

BIO-DATA

A summary of primary bio-data is presented as an overview of the participants.

(1) Primary type of construction performed by respondents employees:

(a)	Commercial	41%
(b)	Heavy-Highway	22%
(c)	Commercial Industrial	16%
(d)	Utility	9.5%

(2) Positions held by respondents:

(a)	Project Managers	49%
(b)	Estimators	21%
(c)	Project Engineers	13%
(d)	Superintendents	8%

(3) Undergraduate Degrees by Respondents:

(a)	Construction	43%
(b)	Engineering	39%
(c)	Business	10%
(d)	Architecture	8%

(4) Experience of Respondents:

The construction experience of participants ranged from 1 to 29 years, with a mean of 10.17 years. Participants had a mean of 5 years experience in their present position.

(5) Post-Baccalaureate Education of Respondents:

(1) Twenty-four percent of respondents had taken coursework at the graduate level.

(2) Eight percent of respondents had a masters degree.

(3) Fifty-two percent had taken some type of continuing education courses.

(6) Professional Registration:

Approximately eleven percent of the respondents held professional registration.

ANALYSIS OF DATA

The investigator utilized sub-programs of the "Statistical Package for the Social Sciences" for computation of one way frequency distribution, mean differences, and contingency table analysis.

Perceptions of Constructors

To investigate perceptions of constructors, the means and standard deviation of responses were computed and rank ordered. Approximately four percent of the elements were perceived by respondents to be "essential,: sixty-seven percent of the elements were included in the "substantially important" level; thirty-four percent of the elements were in the "moderately important" level. No elements were included at the "no" importance level.

The rank order of construction curricular elements is presented in Appendix C.

Influence of Academic Background

A primary purpose of this study was to determine if academic preparation influenced perceptions of importance of the construction education elements.

Elements for which significant differences exist between the means of the two academic groups are listed as follows:

Perceived by construction educated respondents as significantly more important than engineering educated respondents.

- Contractor Organization & Operation
- Construction Safety
- Project Scheduling
- Insurance & Bonding
- Personnel Management
- Labor Law
- Labor Relations
- Fundamentals of Organization & Management

Perceived by engineering educated respondents as significantly more important than construction educated respondents.

- Engineering Physics
- Chemistry
- Geology
- Descriptive Geometry
- Calculus
- Differential Equations
- Mechanics of Materials
- Soil Mechanics
- Hydraulics, Water, Sewage
- Foundation Engineering
- Engineering Surveying
- Earthwork Surveying
- Engineering Economics
- Undirected Elective Courses

Experience as a Controlling Factor

The relationship between academic background and perceptions of curricular element importance when contrasted

with the length of construction experience was significant on nine of the 73 elements. No systematic relationship existed between perceptions of element importance, academic background and length of construction for 87 percent of the elements.

Alternate Sources of Element Instruction

Respondents were asked to select an alternate source of instruction for an element if it was felt the element was inappropriate for an undergraduate program.

(1) Work experience: As indicated in Table II the majority of responses were made by engineering educated respondents.

TABLE II

WORK EXPERIENCE AS AN ALTERNATE SOURCE OF INSTRUCTION RANKED BY FREQUENCY OF RESPONSE

Element	Total Frequency	Frequency Engr.	Frequency Const.	% of Total
Contractor Organization and Operation	19	12	7	30.16
Project Organization and Operation	19	11	8	30.16
Bidding Procedures	15	9	6	23.80
Electrical, Mechanical, Plumbing, Systems: Estimating, Co-ordination	13	8	5	20.63
Construction Equipment	11	8	3	17.46
Construction Safety	10	8	2	15.87

Table II (cont'd)

Element	Total Frequency	Frequency Engr.	Frequency Const.	% of Total
Cost Control and Analysis	10	8	2	15.87
Construction Cost Accounting	10	6	4	15.37

(2) Non-Degree Special Courses

Twenty-four percent of respondents felt Fundamentals of Real Estate should be obtained from short courses.

(3) Graduate Level Courses

Twenty-five percent of respondents indicated advanced structural design, and twenty-two percent indicated Systems Analysis and Operations should be at the graduate level.

(4) Recommended New Elements

While there were 29 different new elements recommended, only one had a frequency of greater than two. Letter writing was recommended by three respondents.

(5) Elements Not Needed

There was little interest in eliminating elements from the guidelines. Seven elements were indicated as "not needed" by less than eight percent of the respondents.

Summary of Responses to Alternate Sources of Element Instruction and Elements Not Needed

A summary of all responses to the categories of work

experience, non-degree special courses, graduate level courses and elements not needed, for each element is a reflection of how important respondents perceived the element to be for undergraduate construction curricula. Eight of the 71 elements were found to have a range of 27 to 43 percent of the respondents indicating these elements should be obtained from a source of instruction other than an undergraduate program. The elements are:

1.	Contractor Organization & Operations	30%
2.	Project Organization & Operations	32%
3.	Electrical, Mechanical, Plumbing Systems: Estimating & Coordination	27%
4.	Systems Analysis & Operations Research	43%
5.	Construction Cost Accounting	27%
6.	Insurance & Bonding	27%
7.	Fundamentals of Real Estate	29%
8.	Advanced Structural Design	40%

No element received sufficient negative response to exclude the element from the guidelines.

Conclusions:

A summary of conclusions based on the findings of the study are as follows:

1. The elements ranking highest are those directly related to the responsibility of the respondent. Conversely, elements relating to upper levels of management are ranked lower in the list of elements.

2. The academic background of the respondent has a significant influence on his perceptions of the importance of elements for a construction education undergraduate curriculum.

3. The length of construction experience does not appear to have a significant influence on the perceptions of constructors toward the level of importance of the construction curricular elements.

4. Work experience still retains a strong influence as an integral part of construction employment. The engineering educated respondent did not appear to strongly support the concept of construction education elements for an undergraduate construction curriculum, instead recommending work experience as an alternative.

5. Special courses and graduate programs, while strongly recommended for a very few elements, did not appear to offer a viable alternative for the majority of elements.

6. From the relative level of importance indicated for the elements and absence of response to the alternative sources of element instruction, with the exception of the elements listed above, the conclusion is drawn that the original element list is as important and valid today as it was when developed in the early 1960's.

Major Recommendations:

Based on findings and conclusions of this study, the following recommendations are offered:

1. Based on the apparent influence of academic background on perceptions of constructors toward elements of a construction curriculum, it is recommended that members of a curriculum advisory committee be comprised of members differing in educational backgrounds to give balance to their input into the deliberations of the construction advisory committee.

2. Respondents to this study placed an emphasis on elements related to construction which could be obtained through work experience. The role and place of required construction internships and co-op programs prior to graduation should be studied.

3. In light of the minority response to alternate sources of element instruction, the AGC education committee should consider additional guideline recommendations con-

cerning the importance of work experience (co-op or internship) prior to graduation; the potential for specialized industry seminars (when available) as supplementary undergraduate instruction; and begin development of guidelines for construction education at the graduate level.

C. Quantitative Analysis of Selected Curricula

Guidelines published by the Associated General Contractor (AGC) and the American Council for Construction Education (ACCE) are two major sources of construction curricular recommendations. Each guideline illustrates the broad range of elements required for a construction curriculum. However, component percentages of the curriculum show slightly different emphases exist between the two guidelines. The AGC guidelines lean toward the sciences and engineering, while ACCE emphasizes management and elective options.

Curricula were selected on the basis of apparent program objectives and wide geographical locations. Arizona State and Northeast Louisiana are accredited by ACCE; Iowa State is accredited by ECPD as Construction Engineering; and Memphis State is accredited by ECPD as Engineering Technology. All programs have a long standing excellent reputation for their respective graduates.

The percentages indicated were derived by interpretation of catalog information by the investigators. While understanding the risk of attempting to use catalog data, the intent was to illustrate curriculum organization under two different sets of guidelines. It should be understood that there is no one correct curriculum, and that accrediting agencies encourage flexibility within reasonable parameters.

TABLE III

QUANTITATIVE CURRICULUM ANALYSIS*
USING AMERICAN COUNCIL FOR
CONSTRUCTION EDUCATION GUIDELINES
FOR SELECTED CONSTRUCTION PROGRAMS

ACCE Form 103	Arizona State	Auburn University	Colorado State	Iowa State	Memphis State	Northeast Louisiana	Average	ACCE
General Education	2.4	11.6	14.8	10.4	15.4	14.1	11.5	12.5
Basic Math and Sciences	14.1	13.5	16.4	28.7	15.4	14.1	17.0	15
Fund. of Construction, Structural and Mechanical Analysis and Design	16.4	12.6	13.9	19.8	11.0	14.1	14.6	17.5
Construction Methods and Procedures	16.4	12.6	16.4	14.4	17.6	16.4	15.6	12.5
Basic Administration	24	10.2	19.7	9.4	4.4	18.8	14.5	15
Construction Management	12.5	10.6	17.2	9.4	11.0	7.0	11.3	17.5
Program Options-Electives	14.8	20.8	0.0	5.9	15.4	14.1	11.8	10
Courses not classified	0.0	8.2	1.6	2.0	9.6	1.5	3.8	0

*In percentages of total curriculum credits.

TABLE IV

QUANTITATIVE CURRICULUM ANALYSIS*
USING ASSOCIATED GENERAL CONTRACTOR
CONSTRUCTION CURRICULAR GUIDELINES FOR SELECTED
CONSTRUCTION PROGRAMS

	Arizona State	Auburn University	Colorado State	Iowa State	Memphis State	Northeast Louisiana	Average	AGC
Basic Math and Science	15.6	16.4	19.7	30.7	17.6	16.4	19.4	22
Basic and Applied Engineering	16.4	12.6	13.9	19.8	11.	14.1	14.7	22/34
Construction	27.3	20.3	30.3	21.8	26.5	21.1	24.6	19/25
Management	24.3	10.2	19.7	9.4	4.4	18.8	14.5	13/16
Socio-Humanistic Studies	17.3	32.3	14.8	16.3	30.9	28.1	23.3	12/15
Courses not classified	0.0	8.2	1.6	2.0	9.6	1.5	3.8	0

*In percentages of total curriculum credits

Let the reader use this data as an indication of the component organization by several outstanding construction programs.

D. Summary of Curriculum Studies

A review of the literature and related studies indicate consistent trends concerning educational needs of construction and characteristics of the "Constructor." The following comments were derived from studies evaluated in this investigation and through experience of the investigator. No attempt was made to statistically prioritize the items. However, those heading the list tend to appear with greater emphasis.

1. Construction is a unique academic discipline.

2. Construction education should be primarily directed toward the "professional" Constructor.

3. In general, construction education does not meet the criteria for engineering definition of "technology." There are situations where all persons may perform the function of a technologist, however, the objective of construction education appears to be management of the construction process.

4. Communication skills (writing, oral and graphics) appear to have a very high priority.

5. Construction education is "education" and not "training." However, certain entry level skills are desirable:

    1. Ability to read and interpret architectural drawings and specifications.

    2. Use of layout instruments.

    3. Ability to do quantity take-off.

    4. Ability to think through construction systems and sequences (Planning).

6. Construction work experience prior to graduation has a high priority when compared to academic experience.

7. Elements of the curriculum should emphasize identification of the problem, analysis of problem, analysis of problem development of alternatives and resolution of the problem in a prudent, economic manner.

8. Construction is a people intensive process, hence, a high emphasis on human relations is desirable.

9. While many curricula emphasize the production of construction[1], some trends in curriculum emphasis toward the concept of comprehensive professional construction services are apparent.

10. The personal qualities of a Constructor, as noted in the AGC guidelines, appear to be as appropriate now as when published in 1967.

    1. The human understanding to be able to work all types of people.

    2. The discipline to think and reason logically.

    3. The technical ability to visualize and solve practical construction problems.

    4. The managerial knowledge to make sound decisions and implement them on a prudent economic basis.

    5. The facility to communicate these decisions clearly and concisely.

    6. The professional stature to provide dynamic leadership in the construction industry and the community.[2]

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[1]Act of producing the physical structure in place.

[2]Associated General Contractors, "Educational Goals and Recommended Construction Curricula for the Construction Industry," Washington, D.C., 1967.

PART III CONSTRUCTION CURRICULAR GUIDELINES

NARRATIVE

Quantification of sub-elements into courses appropriate for inclusion into a construction curriculum, not only depends on the importance of the sub-elements but also on factors unrelated to the importance or scope of the sub-element. Several factors are:

(a) faculty expertise

(b) core requirements of college university

(c) facilities

(d) available resource materials, such as text books

In the previous section, the importance or priority of various sub-elements is shown by their respective ranking. As yet, no data are available to scientifically determine the instructional time desirable or necessary for the various sub-elements. Instructional time more often results from a trial and error process, related to the depth of understanding desired. It is with this process that program emphasis is also determined. The degree to which groups of elements are emphasized give "flavor" to that program.

Many listed elements are accepted as traditional courses. Physics presumes certain accepted concepts have been included, and that a certain level of mathematics is required. Recognized traditional courses are included in several

of the curriculum components.

The elements and sub-elements are categorized into components currently used by ACCE. Since no definitive standards exist placing elements within specific components, the categorization shown is that of the investigator, and does not reflect required distribution of elements for accreditation.

Location of sub-elements and elements within the several components may depend primarily on the depth of mathematics required to develop the concept or skill, and the emphasis desired in the element. Understanding of computer language and utilization may be a function of an engineering emphasis or a business emphasis. In some cases elements may appear under several different components. Program objectives and accreditation standards will determine the emphasis required.

COMPONENT: General Education

Construction is a communication and human relations intensive business. Consistently, practitioners have pointed out the need for high levels of performance in oral and written communications. Introductory composition courses intend only to provide a foundation on which the student builds through out his academic life and on into his career. Communications skills should be utilized in all courses, monitored and critiqued at all levels, by all disciplines.

Socio-humanistic elements assist the students in developing an awareness of social values, human interrelationships and behavior. While these elements were not ranked high by project personnel, these elements form a traditional educational foundation for any academic curriculum.

TABLE V

GENERAL EDUCATION COMPONENT

Element	Minimum* Credits	Recommended* Credits	Comments
English Composition	3	6	
Technical Writing	3	3	
Humanities	3	6	Literature, Art, Philosophy, History Language.
Speech	3	3	
Social Sciences	3	6	Social Science, Economics, Psychology, Political Science, Behavioral Science.
Letter Writing	-	-	A concept to be included in the appropriate element.

*Semester credits

ACCE recommends 15 semester credits. (of 120 credits total)

The "recommended credits" column is intended to show depth of coursework and not a total number of credits hours for the component. ACCE recommendations are shown for reference purposes. Balance of the program must give direction to the total number of credit hours available in each component.

COMPONENT: Mathematics and Science

Mathematics is the basic language of science, construction and engineering. A tool for problem solving, the use of mathematics should be integrated throughout the curriculum. Science forms a broad foundation for understanding the technology and engineering of construction. While the strongest emphasis must be in the mechanics and physical characteristics of materials, most major areas of science are appropriate.

Basic math and science elements are listed first, with optional elements listed in the lower portion of the table. Optional elements may be required by some accreditation standards.

TABLE VI

MATHEMATICS AND SCIENCE COMPONENT

Element	Minimum Credits	Recommended Credits	Comments
Algebra	3(1)	3	(1) May not be accepted for credit toward graduation.
Trigonometry	3(1)	3	
Analytical Geometry	3(2)	3(2)	(2) May be combined with calculus.
Physics	4(3)	8	(3) Minimum entry level of trigonometry.
Geology	3	3	
Computer Programming	3	3	

TABLE VI
(cont'd)

Element	Minimum Credits	Recommended Credits	Comments
Optional(4)			(4) Optional elements may be required in accreditation by some agencies.
Chemistry		4-8	
Statistics(5)		3	(5) Statistics also listed under Fundamental of Business. Statistics is a tool of management and production and should have a high priority for the advanced construction student
Descriptive Geometry		3	
Differential Equations		3	
Engineering Physics		5-10	

ACCE recommends 21 semester credits.

FUNDAMENTALS OF BUSINESS COMPONENTS

These elements represent fundamental concepts relative to business administration and are underlying concepts to management of construction. Most elements will be found in a typical business administration curriculum.

TABLE VII

FUNDAMENTALS OF BUSINESS COMPONENTS

Element	Minimum Credits	Recommended Credits	Comments
Accounting		3	
Management Fundamentals	3	3	
Labor Law	3	3	

TABLE VII
(cont'd)

Element	Minimum Credits	Recommended Credits	Comments
Labor Relations	3	3(1)	(1) Emphasis on construction labor relations and problems.
Economics	3	3	
Computer Programming	3	3	
Personnel Management		3(2)	(2) Recommended electives.
Statistics		3	
Optional			
Finance		3	
Marketing		3	
Real Estate		3	
Systems Analysis		3	

ACCE recommends 21 semester credits.

COMPONENT: Fundamentals of Construction and Engineering

The basic sciences and mathematics are fundamental to understanding concepts relevant to this component. Further, concepts taught should support elements of the construction process and less of the design process. Course objectives should emphasize applications of engineering principles to construction.

It is recommended physics and calculus be the minimum prerequisites to elements listed. Optional elements may be required by some accreditation standards.

TABLE VIII

FUNDAMENTALS OF CONSTRUCTION AND ENGINEERING

Element	Minimum Credits	Recommended Credits	Comments
Statics	3	3	(1) A concurrent properties of materials laboratory is recommended.
Strength of Materials	3(1)	3	(2) Packaging of structural design sub-elements may result in a combination of 4-6 credits.
Fundamentals of Structural Design	3(2)	3-6	
Structural Design: Wood, Steel, Concrete	3	3-6	(3) Either under this component or Business, depending on function.
Concrete Form Design	3	3	
Soils and Foundations	3	3	
Computer Programming	3(3)	3	
Optional Elements			
Engineering Surveying		3	
Soil Mechanics		3	
Hydraulics		3	

TABLE VIII
(cont'd)

Element	Minimum Credits	Recommended Credits	Comments
Dynamics		3	
Thermo-dynamics		3	

ACCE recommends 21 semester credits.

COMPONENT: Technology of Construction

Elements of this component are those which relate to the "how to" of the construction process. Some elements may develop entry level competencies required for acceptable job performance. Elements should enhance a constructor cal ability to visualize and solve practical construction problems. Table IX lists appropriate sub-elements for each element. It is intended that faculty responsible for elements (courses) would further develop required sub-elements according to program objectives.

TABLE IX

TECHNOLOGY OF CONSTRUCTION

Elements	Sub-Elements	Recommended Credits
Architectural Graphics	Orthographic projections, Sketching and lettering, Plan conventions, Plan elements, Materials Integration, Dimensioning systems, Architectural detailing.	2-4

TABLE IX
(cont'd)

Elements	Sub-Elements	Recommended Credits
Building Materials	Properties, Characteristics, Manufacturing, Applications, Specifications, Economics.	2-4
Construction(1) Practices	Orientation into Construction, Construction methods, tools, and equipment, Builder responsibilities, Quality control concepts.	2-4
Construction Surveying	Level and read instrument, Types of instruments, Transfer elevations, Set line and grade, Layout building, Plumb structure Draw and interpret topographical maps, Legal description, Construction measurements.	3-6
Building Systems(2)	Building Codes, Building System types, (Structural) (Architectural) Foundations, Site Development, Methods and techniques, Selection criteria, Economic Analysis, Shop Drawings, Vertical-Horizontal transportation, Specifications, Terminology.	3-6
Mechanical Systems	Basics of heating, cooling and ventilation, Hydronics, Air Systems, Mechanical Equipment, Principles of plumbing, Water Supply, Sanitary Systems, Storm Drainage, Plumbing Fixtures and equipment, Control Systems, Codes.	

TABLE IX
(cont'd)

Elements	Sub-Elements	Recommended Credits
Electrical Systems	Basic Electrical theory, Building electrical circuits, Lighting fundamentals, Electric Power distribution, Motors and Motor controls, codes.	2-4
Plumbing Systems	Water supply, Sanitary Systems, Pumps, Pipe Sizing, Installations, Codes.	1-3
Construction Equipment	Materials of Earthmoving, Soil classification, Power cranes, Excavators, Dozers and Scrapers, Compaction, Concrete Equipment, Equipment Economics, Maintenance, Plant Layout.	2-4

ACCE recommends 15 semester credits.

[1]Emphasis in light construction or required summer work experience, or co-op program.

[2]Combined emphasis in residential, commercial and heavy construction. The "why" of building systems interfaced with the "how" of construction. Presentation should be on a conceptualized basis, identify the problem and then resolve the problem.

COMPONENT: Management of Construction

Elements relate to the primary functions of construction which relate to the administration and management of the construction process. Elements include a broad overview of construction management, with emphasis on a relationship between managerial knowledge and prudent economic decision making. Emphasis is placed on the roles of management and

staff, the construction process and the communication interface.

Elements and sub-elements appropriate to entry level responsibilities have highest priority. While the listed elements are primary, faculty expertise and program objectives may necessitate re-packaging sub-elements within other elements.

TABLE X

MANAGEMENT OF CONSTRUCTION

Elements	Sub-Elements	Recommended Credits
Quantity Takeoff (1)	Interpret Drawings and Specifications, Organize takeoff procedures, Material Quantities.	2-4
Bidding (1)	General Conditions, Production methods, Productivity Analysis materials pricing, Sub-Contracts, Costing equipment, evaluating overhead. Pricing indirects, organization of estimates, Bidding process, Bid strategy, Legal constraints, Bid Recapitulation.	3-5
Planning and Scheduling	Planning Concepts, Schedule methods, concepts, Computer aids, Logic Systems, Resource allocation, Manpower leveling, Cost-time Analysis, Monitor-update-control techniques, Forecasting, Expediting.	3-4

TABLE X
(cont'd)

Elements	Sub-Elements	Recommended Credits
Cost Monitoring Control and Accounting (2)	Cost Coding, Cost Accounting, Documentation, Computer aids, Production Cost Analysis, Inventory Control, Data Storage and Retrieval System, Managerial decision making, Integration of project cost accounting and company financial structure.	2-3
Construction Safety	OSHA Regulations Managing safety processes and programs.	1-3
Project Management	Job budgeting, Job buyout, Sub-contractors, General Conditions, Expediting, Field Organization, Labor Relations, Quality Control, Project Cost, Accounting Productivity Analysis, Documentation, Field Supervision, Labor Construction Claims, Project Closeout, Equipment utilization.	2-4
Management of the Construction Company (3)	Risk management, Construction Contracts, Construction Law, Professional Ethics, Insurance and bonding, Construction - Funding, Organization, Marketing, Personnel, Purchasing, History of Construction, Financial Accounting.	2-4
Optional or Advanced Elements		
1	Professional Construction Management	
2	Conceptualized Estimating	

TABLE X
(cont'd)

Elements	Sub-Elements	Recommended Credits
3	Feasibility studies and project development	
4	Risk management techniques	
5	Contract law and contract Administration	
6	Industrialized Building	
7	Advanced planning and Scheduling Systems	

ACCE recommends 21 semester credits.

[1]Elements of the estimating function. Surveys of contractor and industry needs placed great priority to this function.

[2]Concepts may be interfaced with planning and scheduling, construction cost accounting element or project management.

[3]Construction cost accounting and financial accounting could be separate elements taught by Business.

COMPONENT: Electives and Options

Opportunities for students' personal goals or job specialization is possible only when electives allow deviation from a structured curriculum. Students should be encouraged to select electives which increase depth of technical understanding and/or increase exposure to cultural values and interactions.

Programs with sufficient students may have opportunity to offer optional coursework in special areas, such as; heavy-highway, industrial, mechanical or residential construction.

ACCE recommends 12 semester credits.

C. Composite Model Construction Curriculum

Recommendations for development and organization of a single composite model construction curriculum were derived from many sources. Surveys of element priorities, analysis of existing programs and accreditation requirements which resulted in the curricular guidelines, are reflected in the following composite model curriculum.

Several element sequences are implied by the arrangement indicated. For example, math represents a traditional sequence. Other sequential relationships have been suggested through the educational experience of the investigator, and other construction educators.

It should be emphasized that accreditation does not require a "standard" curriculum. This model is not intended to represent a "standard" curriculum, but rather a suggested methods of organizing elements of the guidelines into a complete system.

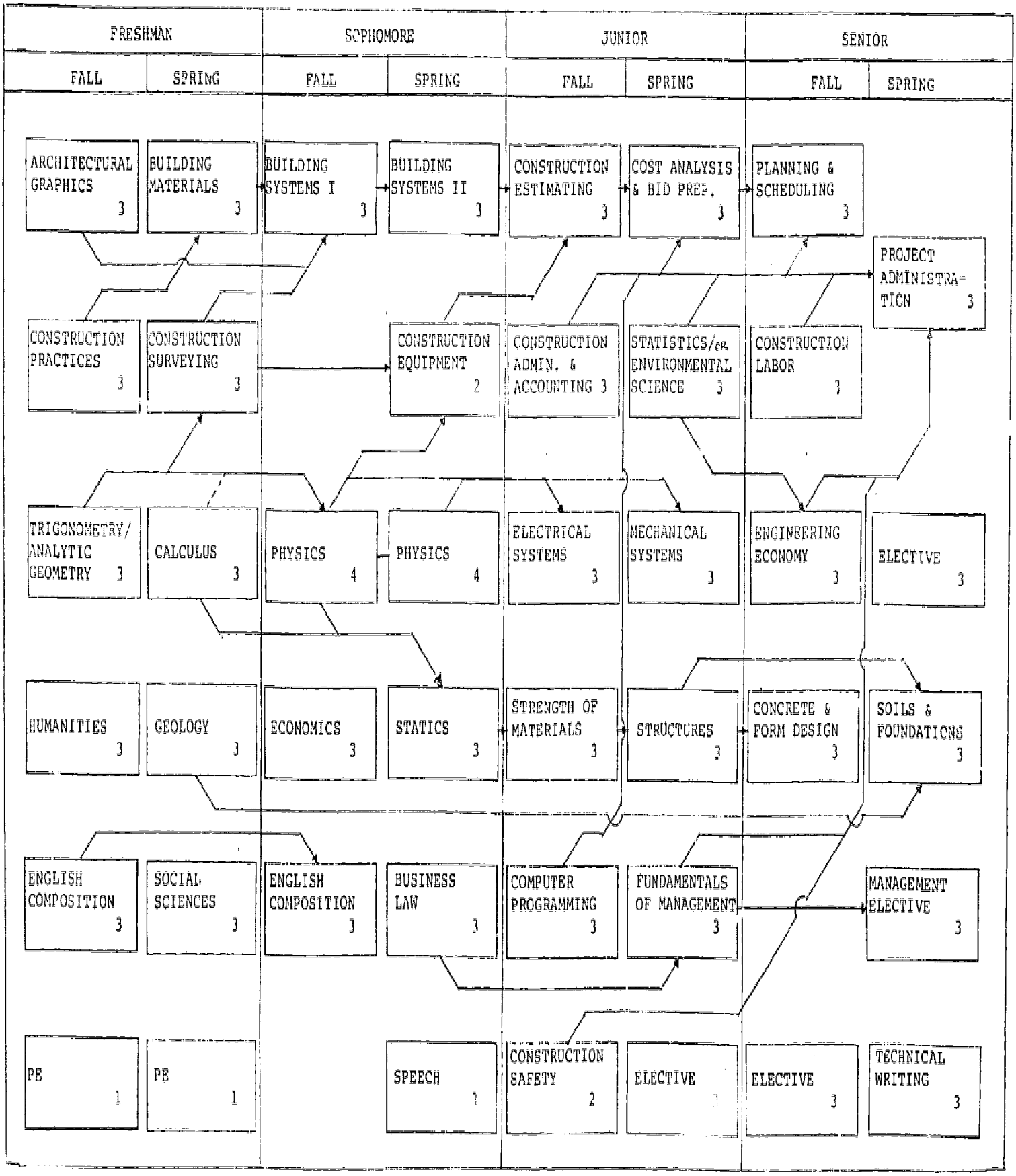
COMPOSITE MODEL
CONSTRUCTION CURRICULUM

	Fall Semester		Spring Semester	
FRESHMAN	Architectural Graphics	3	Building Materials	3
	Construction Practices	3	Construction Surveying	3
	*Trigonometry, Analytic Geometry	3	Calculus	3
	Humanities	3	Social Science	3
	English Composition	3	Geology	3
	Physical Education	1	Physical Education	1
		16		16
SOPHOMORE	Building Systems I	3	Building Systems II	3
	Physics	4	Physics	4
	Economics	3	Statics	3
	English Composition	3	Legal Environment of Business	3
	Humanities/Social Science	3	Speech	3
			Construction Equipment	2
		16		18
JUNIOR	Construction Estimating	3	Cost Analysis & Bid Prep.	3
	Strength of Materials	3	Structures: Steel & Wood	3
	Properties of Materials Lab	1	Fundamentals of Management	3
	Construction Admin. & Accounting	3	Mechanical Systems	3
	Safety	2	Statistics or Env. Science	3
	Computer Programming	3	Elective	3
	Electrical Systems	3		
		18		18
SENIOR	Planning & Scheduling	3	Project Administration	3
	Construction Labor	3	Management Elective	3
	Concrete & Form Design	3	Soils & Foundations	3
	Engineering Economy	3	Technical Writing	3
	Elective	3	Elective	3
		15		15

Total Credits 132 Sem Credits

*Algebra not for credit

CONSTRUCTION: A COMPOSITE MODEL CURRICULUM



PART IV ACCREDITATION

The basic goal of accreditation is to assure program definition and standards as a matter of public record. Accreditation encourages the maintenance of a high quality educational environment. Accreditation processes also determine appropriate quantitative curriculum measures. The proliferation of construction education curricula, the lack of national character for a construction discipline, and the need for professional recognition of the "Constructor" encouraged movement to accreditation for Construction education.

A. American Council for Construction Education

The American Council for Construction Education (ACCE) was incorporated in 1974 as an outgrowth of studies by the Associated Schools (ASC) and the American Institute of Constructors (AIC) and also involved several industry associations. At present, there are seven industry corporate members, American Institute of Constructors, and the Associated Schools of Construction.

The basic purpose of ACCE was to establish a program of voluntary accreditation procedure for construction education curricula, assuring opportunity for students to receive quality professional education in construction.

Eligible institutions include those which offer a

baccalaureate program of no less than four years with a major emphasis on professional construction education. ACCE guidelines state

> "the purpose of the curriculum is to provide for a broad education...responsive to social, economic, and technical developments and shall reflect the application of evolving knowledge in construction and in the behavioral and quantitative sciences."
> ACCE Form 103

ACCE was recognized by the Council on Post Secondary Education as the official accrediting agency for construction education in 1976.

ACCE recommends the curriculum should provide balanced course work in these curriculum components:

General Education	15 sem. cr.
Basic Science	18
Fundamentals of Construction, Structural and Mechanical Analysis and Design	21
Construction Methods & Procedures	15
Basic Administration	18
Construction Management	21
Program Options	12
	120 semester credits

Further information on accreditation procedures and standards may be obtained from:

I. Eugene Thorson, Executive Director
American Council for Construction Education
103 South 4th Street, Suite 6
Manhatten, Kansas 66502

B. Engineering Council for Professional Development (ECPD) Construction Engineering

Concurrent with the development and approval of ACCE by COPA, a joint committee of the Associated General Contractors and American Society of Civil Engineers developed criteria for accreditation of professional level Construction Engineering curricula. The joint committee proposal was accepted by ECPD, and the guidelines published in 1977. ECPD is recognized by the Council on Post Secondary Accreditation as the agency responsible for accreditation of educational programs leading to degrees in engineering and engineering technology.

The quantitative ECPD criteria for the curricula content of construction engineering are:

(a) ½ year of mathematics beyond trigonometry
(b) ½ year of basic sciences
(c) ½ year of Humanities and Social Sciences
(d) 1 year Engineering Sciences
(e) ½ year Construction Engineering Design
(f) ½ year Business Management with a construction emphasis
(g) ½ year Communications, Graphics and elective courses

The Guide for Construction Engineering Visitors on ECPD Accreditation Teams is available from the Engineers' Council for Professional Development, United Engineering Center, 345 East 45th Street, New York, NY 10017.

Engineering Technology

Accreditation of construction technology is possible under the objectives and procedures of ECPD. ECPD defines engineering technology as:

> "...on a continuum extending from craftsman to the engineer. Located nearest the engineer, it requires the application of scientific and engineering priciples in support of engineering activities."[1]

Quantitative criteria for Engineering Technology are:

(a) 3/4 year of basic sciences and mathematics

(b) 1½ years of technological courses

(c) 3/4 year in communications, humanities and social sciences

(d) college algebra is the entry level mathematics

Information on the Engineering Technology accrediting program may be obtained from the Engineers Council for Professional Development.

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[1]Criteria for accrediting programs in Engineering Technology, ECPD. 1976, p. 1.

PART V: NON-ACADEMIC CURRICULUM COMPONENTS

INTRODUCTION:

Attainment of educational and program objectives may best be achieved by including supporting activities relating to development of personal qualities of the student, career counseling and a mechanism through which a meaningful dialogue with industry may take place. The suggestions which follow are intended only to form a nucleus of ideas on which a program may build.

A. Industry Advisory Committee

The basic goal of an industry advisory committee is to provide a synthesis of practitioner input which will assist the programs in meeting the ever changing demands of construction. The advisory committee provides a desirable interface between industry, program and university administration.

Specific objectives would include:

(a) evaluate status of program.

(b) make recommendations on new courses, faculty needs, facilities and other matters relating to program operations.

(c) provide liaison between faculty, students, and industry.

(d) assist program in meeting accreditation requirements.

(e) review progress of graduates and work with student organizations.

Conclusions reached by the technical report suggest members of the committee should be selected from differing

educaticnal backgrounds and experience in industry. Prior knowledge of construction education is not necessary; however, an interest in and understanding of the educational needs of the industry would be desirable.

It is suggested that the committee meet several times each year (e.g.: fall and spring semester), with the opportunity to also take part in a class or student organization activity. Faculty should also have opportunity to meet committee members individually.

The committee should carry the status of appointment by appropriate high level university officials. A preselection screening process by construction faculty is suggested, along with recommendations from industry association education committees. The size of the committee is dependent on local interest and needs; however, a committee of from five to nine persons is manageable.

Parameters of operation should be developed, including term of appointment, meeting dates, and goals and objectives. A committee chairman should be elected, with the program chairman serving as ex-officio member or, perhaps, secretary for the committee.

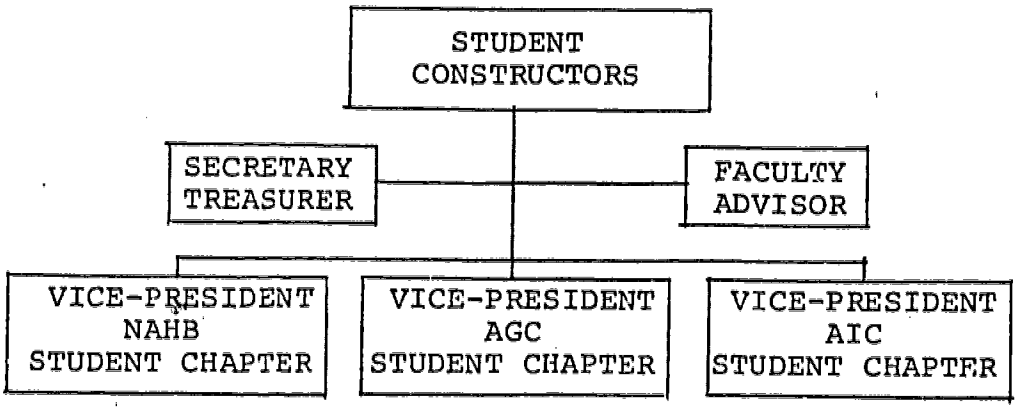
Industry members of ACCE consider an industry advisory committee as a vital part of accreditation requirements. In discussing advisory committees with several program chairmen, the investigator found such committees had a significant impact on the status of the program. Committee members also had a direct benefit from participating; they became aware of the

top students as potential employees.

B. Student Organizations

Opportunity for students to develop organizational abilities and improve leadership qualities will be enhanced through department sponsorship of student organizations. A student "Constructors" club encourages self-identity, opportunity for student - industry liaison, and an emphasis on professional development. The construction employer perceived student participation in such organizations as an integral part of the academic experience.

Construction education is directed toward the total industry. Student activities should offer as much opportunity as possible to relate to a broad view of construction. There are several organizations which offer and encourage student chapters on the campus. The following chart illustrates a method used by several student groups to combine the various chapters.



The vice-president becomes the industry liaison person, coordinating field trips, speakers, and other activities with

the particular organization. Students join the "Constructors" club and participate in one or more of the chapter activities. A small student organization would all meet together; conversely, a large group might have separate meetings, with several joint meetings each year.

Whatever the organizational arrangement, students should be encouraged to participate in peer activities, and further, students should be managing such activities with a minimum of faculty guidance.

C. Academic Advising and Career Counseling

The relative unknown nature of construction places a new emphasis on academic advising, recruiting activities, career counseling, and job placement. The industry is unique in organization, operational methods, and in magnitude. While awareness of the role of the skilled craftsman is high, a similar awareness of the "contractor" or "constructor" role has not existed. Even with the numerous baccalaureate construction programs in operation, knowledge concerning these programs has been slow in reaching counselors, students and parents.

Too often the image conveyed by the term "construction" has been training of craftsman, while the curriculum objective is to "educate" the professional constructor. It is clear a major responsibility of the program, its faculty and the practitioner is to develop procedures to portray construction in an accurate and professional manner.

The following activities relating to the overall

functioning of a program present opportunities for the student and others to understand the construction industry and related careers.

Understanding the construction process and education begins with university staff functions, such as admissions, counseling, placement and the university administration. Periodic conferences with appropriate staff will most certainly improve recruiting of students, on-campus advising and job placement.

Academic Advising

Faculty advisors have the responsiblity of assisting the student in understanding and planning his schedule of courses. In addition, the advisor has an opportunity to know the student, understand the student's goals and suggest other resources when the student needs additional guidance. The following check list highlights potential problem areas:

(1) Evaluation of math abilities, along with other prerequisite abilities and characteristics.

(2) Understanding of required (courses) sequence.

(3) Evaluation and recording of transfer courses.

(4) Selection of electives and program options.

(5) Participation in tutoring and self-help programs.

(6) Encouraging the student to communicate with his/her professors on a regular basis.

(7) Identification of characteristics which

would limit the student's potential in construction.

(8) Maintaining accurate student records.

(9) Participation in industry co-op programs.

(10) Participation in student organizations.

The investigator has found that students seek direction, are concerned about where they are going, and want to talk about their concerns. Time spent in reasonable amounts communicating with students outside the classroom helps the student and also the program. A concerned faculty, interested in the student, helps that student "belong" to the program.

Student Recruiting

High school recruiting is often the sole purview of the admissions office. Providing appropriate literature and educating the college recruiter about construction have high priority. Industry associations have film and literature available for high school and junior college presentations.

Bringing potential students to campus on a "construction" day of activities, with the opportunity to talk with the practitioner and on-campus students provides a most viable means of recruiting. Oklahoma State and others have used this method with good results.

Since construction students are often the best salesman of construction, orientation into "What is Construction?" is most appropriate for students' own understanding.

Serious attention should be given to recruiting of women for construction. Again, college counselors and re-

cruiters need to be aware of the nature of construction and characteristics of the constructor. Literature should reflect an accurate overview of construction opportunities.

A question often raised by high school students is: "What is the difference between engineering and construction?" Faculty advisors and college recruiters should have formed an understanding which enables them to communicate the differences. The phrase which describes the goal of a constructor - "to manage the construction process" - is a point of beginning to describe the professional constructor.

Finally, new programs will find a review of existing program brochures helpful in obtaining ideas on content and format.

Career and Placement Counseling

Career counseling begins with the first contact between student and faculty. Orientation into construction processes and people roles should probably begin with a specific orientation course early in the construction program. Opportunities to communicate with the "live" constructor begin the process of understanding "where am I going?" and "what is construction?"

Many campuses have career guidance centers with various testing programs available for the student to better understand himself. Encouraging (or requiring) the student to obtain summer employment will further aid the understanding of the construction process and the student's potential role as a constructor. It is important that the student's expectations

of construction reasonably match those of the real world.

With respect to job placement, the following comments, primarily derived from the investigator's experience, are offered as a point of beginning.

1. Workshops with seniors on job-seeking procedures, involving letter writing, résumé writing, interviewing techniques, are effective in getting students underway. The placement office or career planning office will be of assistance in planning such workshops.

2. Developing in-state and out-of-state contractor addresses is a major task. Association membership directories will provide a primary resource.

3. The placement office should be educated in the nature and scope of the construction industry.

4. Many companies prefer to contact the program directly for available graduates or to obtain references.

5. Larger construction companies are geared to recruiting processes, with "regular" schools visited each year. The new program may have to sell its graduates until the quality of the graduate is established.

6. Small construction firms, with the president also serving as personnel officer, may prefer the student to come to his office.

7. Direct communication with the construction company is probably the most effective, particularly when done in person. Mass mailings may not be productive, unless the letter and résumé are designed to catch a busy executive's attention.

Experience has shown the best advertisement for a program is the performance and professional nature of its graduates. Department monitoring of its graduates will give direction to placement counseling.

D. Faculty Selection

The comments and suggestions which follow are those of the investigator, gained from experience and many discussions with other construction faculty. The investigator presumes a faculty selection committee will determine appropriate criteria, with input from an industry advisory committee and within the guidelines of university policy.

Construction faculty represent a diverse background of experience and education, more strongly influenced by the location of the program than program goals. Only in recent years have undergraduate construction degree graduates entered teaching after receiving a masters degree in construction management or business.

Still, acquisition and integration of construction faculty into academia present unique problems. While the traditional academic requirements of degrees and publications are recognized, these requirements do not often reflect credit for experience in construction or for professional registration. The fact that the masters degree is the terminal degree for a construction graduate at the present time limits the availability of candidates for many programs. Several engineering doctoral programs with a construction emphasis are available. However, these are generally restricted to holders of a civil engineering undergraduate degree, not a construction degree.

While no specific data are available, it appears that the two primary sources of doctoral degrees held by those

presently teaching in construction are engineering (design oriented) and education (administration emphasis). Neither of these degrees would appear to offer the most appropriate background for construction.

The broad scope of construction courses, restricted by limited faculty positions, require that faculty be of diverse backgrounds and flexible in teaching responsibilities. The technical report suggests that perceptions of construction education are influenced by the respondent's education. This suggests that faculty be selected not only from construction but from the disciplines supporting construction: architecture and engineering.

Appropriate criteria for a construction faculty might include:

Education:

B.S. - Construction, engineering, architectural engineering.

M.S. - Construction, engineering, business management.

Ph.D. - Desirable, but not at expense of appropriate experience.

Optional - Professional registration would be desirable for some of the faculty; this may depend more on local requirements, administrative location of program and program objectives.

Experience: A minimum of 3-5 years in general construction, with broad exposure to functions of the construction process. Greater experience would be desirable, however, the classroom is not an appropriate place to retire. The Selection Committee should determine if the candidate has ten years of

experience or one year of experience, ten times.

Teaching Experience: Prior teaching experience would be most desirable; however current demand for construction faculty exceeds supply. Practitioners with changing career goals offer potential as new faculty. Understanding of the academic world, educational processes, salary potential and promotion requirements should be clearly understood by the practitioner entering teaching as a career.

Other desirable characteristics of construction faculty would include:

(a) interest in developing the educational delivery of his/her area of expertise.

(b) interest in working with students, both in advising and extracurricular activities.

(c) involvement with industry associations, in both a public relations and continuing education relationship.

(d) willingness to pursue the research and service aspects of the academic world.

PART VI: PROFESSIONAL AND INDUSTRY ASSOCIATIONS

NARRATIVE:

Development of construction curricula over the past several decades has been a combined effort of several professional and industry associations. Through these respective education committees, these organizations offer the new program and its faculty a valuable source of publications, curriculum guidance, philosophical background, and liaison with the "real" world.

Construction faculty report the construction practitioner and related associations are receptive to continuing dialogue and cooperative effort in developing program resources, such as: speakers, field trips and in many cases, financial support for equipment or travel funds. Communication between university and local, state and national professional and trade associations is necessary for a viable, well balanced construction curriculum.

The associations listed are those appearing to be most prominent in construction education at the baccalaureate level. There are many other trade associations active in local areas able to provide active support and resources for a program. This listing and descriptions were not intended to be all inclusive, but rather, to provide a starting point for the new construction faculty member and a developing curriculum.

ASSOCIATED SCHOOLS OF CONSTRUCTION

Description: Organized in 1965 as the first association of academic institutions concerned with construction education at the baccalaureate level. With approximately fifty member institutions, the ASC represents a broad base of curricula philosophy dedicated to the development of the professional constructor.

Annual meetings are held in April each year, on a selected university campus. The 1979 convention is scheduled for Purdue University and in 1980, at California State Polytechnic University. Officers are elected from faculty of member institutions. ASC is a corporate member of the American Council for Construction Education. Meetings are open to non-members, practitioners and construction students.

Current President: 1978-79

Dr. James W. Young, AIC
University of Southern Mississippi
Box 5137 Southern Station
Hattiesburg, MS 39401

Mailing Address:

Associated Schools of Construction
511 Glenbrook Centre
1140 N.W. 63
Oklahoma City, OK 73116

ASSOCIATED BUILDERS AND CONTRACTORS, INC.

Description: A national trade association of contractors espousing the merit shop concept. The association is open to all types of contractors and sub-contractors, with local and state chapters throughout the country. Initial educational programs were directed toward skill training for crafts. In recent years, attention has been given to management

training and developing curricula in the community and junior colleges. ABC will provide speakers for appropriate construction courses on merit shop operations.

National Staff:

Mr. John R. Trimmer
Assistant to the President
P. O. Box 8733
Baltimore - Washington International Airport
Maryland 21240
(301) 796-5750

*ABC is a corporate member of ACCE.

NATIONAL ELECTRICAL CONTRACTORS ASSOCIATION

Description: A trade association providing a variety of services to members, including a comprehensive assortment of educational programs designed to train and provide continuing education to management, technical, supervisory and administrative employees. The programs are presented as seminars, workshops and self-study courses

State and local chapters of NECA are encouraged to work with construction programs at the universities. The liaison format and specific areas will be dependent on local curriculum needs. Local chapter addresses may be obtained through national offices of NECA.

National Staff:

Mr. Sanford E. Blumenthal
Manager, Management Services
7315 Wisconsin Ave.
Washington, DC 20014

*NECA is a corporate member of ACCE

NATIONAL ASSOCIATION OF HOME BUILDERS

Description: A national trade association of builders and others involved in residential construction industry. Organized around local, state and regional chapters, NAHB holds a national convention in January of each year. NAHB is the largest of the construction industry trade associations.

Educational seminars and training programs are developed for members, and educational materials are available through the national office. NAHB encourages student chapters at the university level and has available model constitutions. The application for a student chapter is approved at the national level. Scholarship monies are available on a limited basis, particularly in conjunction with local chapter support.

National Staff:

Director
Training and Education Department
National Association of Home Builders
15th and M Streets, N.W.
Washington, DC 20005

CONSTRUCTION ENGINEERING COMMITTEE
AMERICAN SOCIETY FOR ENGINEERING EDUCATION

Description: Established in recent years as a subdivision of ASEE, to encourage interchange of information between the industry and educators; promote broad and rigorous educational programs that meet the needs of the construction industry; keep engineering educators informed of the changing and diverse educational requirements of the construction industry.

Annual meetings are held in conjunction with the national convention of ASEE, held in June each year.

Current Chairman: 1978-79
Dr. Bill Ledbetter
Civil Engineering Department
Texas A & M
College Station, TX 77843

Mailing Address:
American Society for Engineering Education
Suite 400 One Dupont Circle
Washington, DC 20036

EDUCATION COMMITTEE AND HIGHER EDUCATION SUB-COMMITTEE
ASSOCIATED GENERAL CONTRACTORS OF AMERICA

Description: Concerned with education and training appropriate to the construction industry, the AGC Education Committee developed recommendations for construction curricula at the baccalaureate level in the mid-1960's. The Education Committee and the Higher Education Sub-Committee meet in the fall and mid-spring during the annual mid-year board meeting and convention. Construction faculty are invited to sit in on committee discussions.

Current Chairman:
Ralph Korte, AIC
Korte Construction Company
1115 Broadway
Highland, ILL 62249

AGC Staff and Address:
Ernie Jones, Director
Construction Education Division
Associated General Contractors
1957 E. Street, N.W.
Washington, DC 20006

THE AGC, ASC, ASEE, AIC INDUSTRY LIAISON COMMITTEE
The "Poly" Committee

Description and Purpose: Organized in recent years as an offshoot of joint AGC committees with several academic

groups, the Poly Committee serves to promote understanding of the goals and objectives of groups concerned with construction education. Apparently co-hosted by AGC and AIC, the "Poly Committee" presents a forum prior to the annual AIC convention.

Contact:

Mr. Glenn Dowdy, Executive Director
American Institute of Constructors
511 Glenbrook Centre
1140 N.W. 63rd
Oklahoma City, OK 73116

or

Mr. Ernie Jones, Director
Construction Education Division
Associated General Contractors
1957 E. Street, N.W.
Washington, DC 20006

AMERICAN INSTITUTE OF CONSTRUCTORS

Description: Incorporated in 1971 to promote excellence in construction by establishing standards of ethics and competence for the professional constructor; by promoting the study and advancing the practice of construction; by facilitating the exchange of information and ideas within the profession.

The American Institute of Constructors has been instrumental in the development of accreditation for construction education and continues to be a catalyst between the construction educator and the professional constructor.

National, regional and state seminars are open to construction personnel, students and related professions. Annual forums are held in late January in selected cities.

Current President: 1979

E. Grant Hesser, AIC
Charles V. Maescher and Co., Inc.
P. O. Box 6098
Cincinnati, OH 45206

Mailing Address:

Glenn Dowdy, Executive Director
American Institute of Constructors
511 Glenbrook Centre
1140 N.W. 63rd.
Oklahoma City, OK 73116

SIGMA LAMBDA CHI

Description: A national scholastic honor society for construction. Founded in 1949 at Michigan State University, there are now active chapters at nineteen colleges and universities throughout the United States.

The fundamental purpose of Sigma Lambda Chi is to give recognition to outstanding students in construction. Students are selected on the basis of scholastic achievement, contribution to the program and professional development.

Upon approval of the National Executive Committee, a Chapter of Sigma Lambda Chi may be established at any college or university granting a baccalaureate degree in construction or approved allied field.

National Executive Secretary:

Professor David Marchman
Box 8417 Southern Station
University of Southern Mississippi
Hattiesburg, MS 39401

APPENDIX A

RANK ORDER OF INDIVIDUAL CONSTRUCTION TECHNOLOGY COMPETENCY ELEMENTS FOR LEVEL OF IMPORTANCE AS RATED BY GRADUATES, EMPLOYERS AND FACULTY FOR ENTRY-LEVEL CONSTRUCTION TECHNOLOGISTS

Rank	Competency Element
1.0	Analyze plans and specifications as to accuracy and completeness.
2.0	Speak clearly & concisely when making oral presentations.
3.0	Skill to compute quantity takeoffs for excavation, etc. to determine unit price est.
4.0	Read and interpret technical papers & instructions relating to const. activities.
5.0	Knowledge of competitive bidding procedures and practices.
6.0	Knowledge of the various types of construction contracts such as lump sum, etc.
7.0	Interpreting and construction cost, expenditure and progress graphs and charts.
8.0	Role and legal responsibilities of subcontractors.
9.0	Project planning, schedule, and control using network techniques (CPM or PERT)
10.0	Purchasing function for dealing with vendors of supplies, etc. on const. project.
11.5	Knowledge of the six basic elements of construction contracts.
11.5	Project organization and the roles, duties, and responsibilities.
13.0	Properties and uses of wood, timber, clay products, cement, concrete, concrete aggregates, limes and plasters.
14.0	Economic use of steel, reinforced concrete and wood in building and eng. structures.
15.0	Legal relations
16.0	Construction safety management and administration.
17.0	Write technical reports & proposals concerning construction activities.
18.0	Acceleration clauses in construction contracts.
19.5	Importance of safety as a method to reduce labor costs.
19.5	Concrete mixing, placing, finishing and curing practices.
21.0	Use handbooks, catalogs, guidebooks, and other commercial information.
22.0	Construct critical path and PERT network diagrams.
23.0	Compute earthwork quantities for excavation and fill.
24.0	Techniques and procedures used in the preparation of const. specifications.
25.0	Conduct construction surveys such as laying out building lines, etc.
26.0	Principles of the delegation of authority and responsibility
27.5	Union working rules regarding supervision of workers.
29.0	National, state, and local building and zoning codes.
30.5	Theory and practice of placing reinforcing steel for slabs, beams and columns.
30.5	Check lines and grades set by the field engineer.

Rank	Competency Element
32.0	Interpret civil engineering cartographic maps.
33.0	Organization and functions of the labor unions.
34.0	Prepare simple architectural drawings.
35.0	Private vs. public contracts.
36.0	Plane surveying.
37.0	Reinforcing bar sizes, shapes, lengths and weights.
38.5	Using calculators.
38.5	Quality control techniques for maintaining standards of quality construction.
40.0	Principles of construction financing.
41.0	Theory and design of concrete mixtures.
42.0	Installation practices for water supply, plumbing, electrical distribution systems.
43.0	Earth process and materials of engineering structures.
44.5	Prepare working drawings for specific portions of the project.
44.5	Theories, policies and practices governing employer-employee relationships.
46.0	Federal and state labor laws and contracts.
47.0	Records and records management.
48.0	Principles of risk-bearing and insurance pertinent to the construction contractor.
49.0	Variety of bonds available to the construction contractor.
50.0	Theory and design of wood and timber structures.
51.5	Use of internal financial data, for managerial decision-making.
51.5	Analyzing sites upon which buildings & industrial plants may be constructed.
53.0	Ferrous metals, their production, properties, sizes, shapes and applications.
54.5	Fasteners such as nails, screws, bolts, flush shells, etc.
54.5	Skill in freehand sketching.
56.0	Reinforced masonry wall construction.
57.5	Erection procedures for tilt-up wall construction.
57.5	Purchase order expediting.
59.0	Soil compaction tests, specific gravity, grain sizes, and classification.
60.0	Carpentry and residential concrete foundation construction.
61.5	Design of structural steel components.
61.5	Compose and deliver speeches.
63.5	Concrete slip-form construction practices.
63.5	Cold weather concrete construction practices.
65.0	Plotting surveying data as related to contour profiles and topography.
66.0	Real property investment, development, planning, zoning and developing.
67.0	Theory and design of pre-stressed reinforcing steel for slabs, beams & columns.
68.0	Principles and concepts underlying financial reports.
69.5	Theory and design of reinforced masonry walls.

Rank	Competency Element
69.5	Installation of electrical equipment.
71.5	Structural steel erection procedures.
71.5	Installation practices for heating, ventilating, A/C and vertical trans. systems.
73.0	Metric system as applied to the construction industry.
74.0	Keep neat, accurate, complete field survey notes.
75.0	Theory and practice of land surveying for subdivisions & filing and recording deeds.
76.0	Non-ferrous metals, their production, properties, sizes, and applications..
77.0	Labor movement, goals, economic power, jurisdictional disputes, collective bargaining and government regulation.
78.0	Equipment selection for earthmoving activities.
79.0	Lay out studs, joists, rafters and stair stringers.
80.0	Collecting soil and concrete samples for use by project inspectors and laboratories.
81.0	Basic use of tools such as hand saws, framing square, hammers, etc.
82.0	Data Processing applications in estimating.
83.5	Use PERT and CPM in conjunction with electronic data processing equipment.
83.5	Basic house wiring.
85.0	Letter neatly.
86.5	Draw orthographic projections relative to the elements of construction.
86.5	Physical facilities of industrial plants such as building, machinery, and equipment.
88.5	Obtaining data from seismic, planning, population, zoning, highway, topographic and geologic maps to aide site analysis.
88.5	Economic supply and demand factors.
90.5	Conduct interviews and counsel with employees.
90.5	Materials handling equipment including tractors, trucks, scrapers loaders, etc.
92.0	Basic laws of statics and dynamics.
93.0	Functioning of a modern market economy.
94.0	Current practices in the transmission, utilization and application of electrical power.
95.0	Care and adjustments required for field survey instruments.
96.5	Applications and principles of industrial design.
96.5	Comfort control air distribution, duct design, fans, filters, etc.
98.5	Ability to apply the principles of physics.
98.5	Criteria for identifying development & training needs of managers, supervisors and workmen.
100.5	Industrial organizations and supervisory systems.
100.5	Prepare profiles and topographic maps from field survey data.
102.0	Elements of gas, and electric arc, welding.
103.0	Woodworking and woodworking machines and general finishing procedures.

Rank	Competency
104.0	Basic concepts in descriptive and differential statics.
105.0	Production, distribution, and consumption of goods and services.
106.0	Fundmentals of electronic data processing and programming.
107.0	Prepare multi-story building construction drawings.
108.0	Direct and alternating current circuits.
109.0	Hoisting signs and signals.
110.0	Solve problems by the use of computers and stored programs.
111.0	Heavy equipment maintenance and repair.
112.0	FORTRAN programming language.
113.0	Make models of building and industrial equipment.[1]

[1]A.W. Grossman, "Importance and Proficiency of Construction Technology Competency Elements," Unpublished doctoral dissertation, University of Missouri-Columbia, 1975.

APPENDIX B

RANK ORDER OF RESPONSES BY NATIONAL CONTRACTORS TO SURVEY ON SKILLS OR KNOWLEDGE DESIRABLE FOR CONSTRUCTION CAREER ENTRY LEVELS[1]

Rank	Elements
1	Estimating and quantity takeoff
2	Written communications
3.5	Bidding Procedures
3.5	Construction Supervision
5	Oral communications
7	Construction contracts
7	Cost control methods
7	Specifications interpretation
9.5	Project cost accounting and analysis
9.5	Analyze construction drawings for errors and omissions
11	Leadership styles and skills
12.5	Problem solving techniques
12.5	Planning and controlling manpower needs
14.5	Scheduling techniques
16	Earthwork and foundations
17	Quality control procedures
19	Change order administration
19	Structural Systems - construction
19	Construction Layout
22.5	Formwork

APPENDIX
(cont'd)

Rank	Elements
22.5	Building Systems integration
22.5	Employee motivation
22.5	Personnel evaluation and management
25	Contract Administration procedures
26	Budgeting
27	Construction Safety Procedures
28	Legal aspects of construction
30	Cost time analysis
30	Productivity analysis
30	Liens and Construction Law
32.5	Inspection procedures
32.5	Construction progress reporting
35.5	Production group organization responsibilities
35.5	Mechanical systems-construction
35.5	Electrical systems-construction
35.5	Building materials technology
39	Soil characteristics and soil handling
39	Employee training and counseling
39	Value engineering
41	Construction insurance coverage
42	Sanitary systems construction
43	Working capital analysis
44.5	Analysis and use of financial statement
44.5	Company organization and functions

APPENDIX
(cont'd)

Rank	Elements
46	Bonding and security
48	Management of Funds-Internal
48	Labor negotiations
48	Building codes
50	Expediting
52	Purchasing procedures
52	Scheduling of Funds Flow
52	Receipt and disbursement control
54.5	Feasibility analysis-investment analysis
54.5	Retentions
56.5	Life cycle costing
56.5	Use of computers
58	Records management
60	Intra-professional responsibilities/ relationships
60	Penalty and incentive clauses
60	Warranty and guaranty service
[illegible]	Market analysis
63.5	Regulatory constraints
63.5	Prospective funding
63.5	Handling grievances-union regulations
66	Resource leveling and allocation
67	Graphic skills-drafting and sketching
68	Legal factors of organization types

APPENDIX
(cont'd)

Rank	Elements
69	Types of builder loans
70	Value determination

[1]Flaherty, M.J., "Curriculum Education Study," unpublished informal study, University of Washington, 1977.

APPENDIX C

RANK ORDER OF CONSTRUCTION
CURRICULAR ELEMENTS
BY EXPERIENCED CONSTRUCTION PERSONNEL.[1]

Rank	Elements	Means
1	Construction Surveying	2.67
2.5	Specifications and Drawings	2.59
2.5	Oral Communications	2.59
4	Fund. of Structural Design	2.43
5	Properties of Construction Materials	2.33
6.5	Algebra	2.32
6.5	Trigonometry	2.32
8.5	Quantity Take-off	2.30
8.5	Structural Design: Wood, Concrete, Steel	2.30
10.5	Project Scheduling and Control	2.27
10.5	Mechanics of Materials	2.27
12	Concrete Form Design	2.25
13	Cost Estimating	2.24
14	English Composition	2.22
15	Surveying: Earthwork	2.19
16	Engineering Surveying	2.08
17	Technical Report Writing	2.06
18	Graphics: Architectural	2.03
19	Construction Contracts	2.09

APPENDIX
(cont'd)

Rank	Elements	Means
20	Statics and Mechanics	2.00
21	Construction Economics	1.98
23	Orientation into Construction	1.95
23	Soil Mechanics	1.95
25.5	Analytic Geometry	1.92
27	Construction Contract Law	1.87
28	Professional Ethics	1.84
29	Building Materials	1.83
30	Organization and Management	1.81
31	Graphics: Mechanical	1.78
32.5	Personnel Management	1.75
32.5	Engineering Physics	1.75
34	Business Law	1.73
35.5	Directed electives	1.71
35.5	Descriptive Geometry	1.71
37.5	Construction Safety	1.70
37.5	Logic	1.70
39	Building Codes	1.67
40	Electives (undirected)	1.60
[illegible]	Construction Equipment	1.57
	Labor Relations	1.57
43	General Physics	1.56
44	Bidding Procedures	1.54
45.5	Project Organization & Operation	1.52

APPENDIX
(cont'd)

Rank	Elements	Means
45.5	Calculus	1.52
47	Labor Law	1.50
48	Construction Cost Accounting	1.48
49	Principles of Accounting	1.46
50.5	Hydraulics, Water, Sewerage	1.44
50.5	Engineering Economics	1.44
52	Psychology	1.41
53	Insurance and Bonding	1.40
54	Contractor Organization and Operation	1.38
55	Electrical; Estimating and Coordination	1.35
56.5	Geology	1.33
56.5	Electrical; HVAC Theory and Design	1.33
58	Principles of Economics	1.32
59	Computer Programming	1.25
60	Social Science, History and Government	1.19
61	Finance	1.17
62.5	Statistics: Business	1.13
62.5	Highway Engineering	1.13
	Computer Data Processing	1.08
65	Humanities: Literature and Fine Arts	1.03
66	Differential Equations	1.00

APPENDIX
(cont'd)

Rank	Elements	Means
67	Chemistry	.91
68	Philosophy	.83
69.5	Advanced Structural Design	.71
69.5	Systems Analysis and Operations Research	.71
71	Real Estate Fundamentals	.68

[1]Young, J.W., "Analysis of Construction Curricular Elements," Published doctoral dissertation, University of Northern Colorado, 1977.

APPENDIX D

EDUCATIONAL GOALS AND RECOMMENDED CONSTRUCTION CURRICULA FOR THE CONSTRUCTION INDUSTRY

Increasingly, the Construction Industry is coming to realize that it will be served best by personnel specifically educated and trained in the managerial and scientific techniques necessary to meet the ever-increasing demands of this rapidly changing technological age. Few industries have more diversified personnel requirements. Professional engineers, business managers, technicians and skilled craftsmen, together form its manpower framework. Probably no other industry is so beset by recurrent personnel shortages at all levels. It is more than obvious that expanded training of manpower is one of construction's most pressing needs.

To this end, the Construction Education Committee of the Associated General Contractors of America desires to set forth education programs which it feels will both meet the needs and enhance the future of the industry. Programs covered here are designed primarily for managerial, supervisory and technical personnel and are to be considered as complementary to those being developed for the training of craftsmen.

Construction Management Education

While the Industry shall always require many persons trained solely as engineers or in the managerial skills, it is increasingly clear that the most effective training for the Industry's leaders at all levels of managerial responsibility is a meaningful synthesis of engineering and business management education at the University level which shall be termed Construction herein and shall entitle one, who satisfies all requirements, to a Baccalaureate Degree. In order to assist maximum growth in one's career development, construction education should contribute to these personal qualities:

1) The knowledge and understanding to be able to work with all types of people.
2) The discipline to think and reason logically.
3) The technical ability to visualize and solve practical construction problems.
4) The managerial knowledge to make sound decisions and implement them on a prudent economic basis.
5) The facility to communicate these decisions clearly and concisely.

6) The professional stature to provide dynamic leadership in the construction industry and the community.

The curricula recommended here is in broad outline only. The implementation of the curricula and the sponsoring college (Engineering, Architecture, Business, etc.) would depend upon the professional education and experience of the faculty and the educational facilities available at the various colleges and universities.

Whether the course is given in four years or five yars, the percentage mix of the several ingredients of total course content should be approximately the same, but obviously the five-year course should delve more deeply into all areas. An integrated program of engineering, construction, and business is recommended, but this is not to say that worthwhile results may not be obtained by adding a fifth year of business and construction to an undergraduate engineering program.

Construction may be roughly divided into the two areas of:

1) Heavy and Highway Construction
2) Building Construction

While basically educational requirements for the two are the same, it is recognized that the emphasis on engineering science and design should be greater for Heavy and Highway Construction. Other than this, no good purpose is served by stressing differences and from the standpoint of most fully utilizing the capabilities of both faculty and educational institutions, courses should be structured to serve students interested in either area.

For Building Construction, a curriculum is recommended as follows: (Note - percentages, to be regarded as approximations, refer to total course content of 4 or 5 year curriculum)

A) Basic Science - (32%) to include:
   1) Mathematics
      a) Analytical Geometry
      b) Calculus
   2) General Physics
   3) Chemistry or Engineering Geology
   4) Computer - data processing and problem solution
   5) Graphics
   6) Statistics

B) Basic & Applied Engineering - (22%) to include:
   1) Mechanics
   2) Mechanics of Materials
   3) Structural Engineering
      a) Fundamentals of Structural Theory and Design
      b) Soil Mechanics and Foundation Engineering

c) Structural Design - Wood, Reinforced concrete, Steel, Aluminum, etc.

4) Surveying

5) Engineering Economy & Cost Analysis

C) Construction - (20%) to include:

1) Orientation

2) Contracts, Plans & Specifications

3) Cost Estimating & Bidding

4) Construction Operation

a) Contractors Organization

b) Project Organization & Supervision

c) Building Materials & Methods of Construction

d) Construction Equipment

e) Construction Safety

5) Project Scheduling & Control

6) Construction Economics & Cost Control

7) Electrical Installations

8) Heating, Ventilating & Air Conditioning Installations

9) Mechanical Installations

10) Systems Analysis, Operations Research, etc.

D) Management - (16%) to include:

1) Economics

2) Accounting

3) Finance including Insurance & Bonding

4) Personnel Management & Labor Relations

5) Business Law

6) Fundamentals of Real Estate & Building Codes

7) Organization Management

E) Socio-Humanistic Studies - (15%) to include:

1) English - Composition & Literature

2) Speech

3) Technical Report Writing

4) Political Science - American Government

5) Social Science

6) Psychology

7) Ethics

8) Electives

For Heavy and Highway Construction a curriculum is recommended as follows:

A) Basic Science - (22%) to include:

1) Mathematics

a) Analytical Geometry

b) Calculus

2) General Physics

3) Engineering Geology

4) Computer - data processing and problem solution
5) Graphics
6) Statistics

B) Basic & Applied Engineering - (34%) to include:
1) Mechanics & Statics
2) Mechanics of Materials
3) Structural Engineering
a) Fundamentals of Structural Theory and Design
b) Soil Mechanics & Foundation Engineering
c) Structural Design - Wood, Reinforced concrete, Steel, Aluminum, etc.
d) Advanced Structural Design
4) Surveying, Earthwork, Principles of Photogrammetry
5) Hydraulics, Water and Sewerage
6) Highway Engineering
7) Engineering Economy & Cost Analysis

C) Construction - (19%) to include:
1) Orientation
2) Contracts, Plans & Specifications
3) Cost Estimating & Bidding
4) Construction Operation
a) Contractor's Organization
b) Project Organization & Control
c) Materials & Methods of Construction
d) Construction Equipment
e) Construction Safety
5) Project Scheduling & Control
6) Construction Economics & Cost Control
7) Systems Analysis, Operations Research, etc.

D) Management - (13%) to include:
1) Economics
2) Accounting
3) Finance including Insurance & Bonding
4) Personnel Management & Labor Relations
5) Business Law
6) Organization Management

E) Socio-Humanistic Studies - (12%) to include:
1) English - Composition & Literature
2) Speech
3) Technical Report Writing
4) Political Science - American Government
5) Social Science
6) Psychology
7) Ethics

Large portions of both curricula are engineering. It is recognized that some institutions may find it impractical for reasons of accreditation requirements, faculty experience and interest or institutional facilities to offer Construction in the College of Engineering. In any case, it is intended that the curricula recommended herein be offered with no less rigor than the traditional engineering course of study.

Objectives and Goals

a. To establish goals and objectives for the development and advancement of construction education and to provide the organized means and to take such lawful action as shall accomplish them.

b. To assist institutions of higher learning and other appropriate schools and agencies in the establishment, development and advancement of construction education programs

c. To establish and promote professional and technical ideas, standards and identity for construction education programs offered by member educational institutions offering baccalaureate and higher degree programs.

d. To promote the welfare and standing of construction education in other institutions and related fields and agencies.

e. To promote professional ideals, standards and identity for individuals who seek after or occupy responsible roles in construction.

f. To encourage careers in construction education and to enhance the standing and growth and development of all individuals who serve or follow the field.

g. To encourage understanding and cooperation of the public, the industry and individuals in the purposes and aims of construction education.

h. To innovate, improve and adjust curricula, educational and teaching processes and instructional materials to meet changing conditions.

i. To develop, promulgate and adopt model curricula in accordance with the desires of the member schools.

j. To encourage, coordinate and participate in research for construction.

k. To engender a working relationship and a fraternal spirit among teachers, counselors and administrators at educational institutions and among practicing members of the construction industry.

l. To be at all times a just and orderly forum for the exchange of knowledge.

Organizational Members

a. **Institutional members** shall be those institutions having at least one baccalaureate or higher degree construction program recognized by an appropriate agency or agencies formally listed by the Association.

b. **Associate members** shall be institutions of higher education, including junior and community colleges, not meeting institutional member requirements, but which are accredited by a major regional educational association.

c. **Industrial members** shall be industrial organizations demonstrating a constructive interest in construction education.

d. **Government members** shall be government agencies having a constructive interest in construction education.

Summary of 1977 Survey of A.S.C. Member Institutions

44 of 48 schools reported

Total Undergraduate Students =	5,716
Total Graduate Students =	116
Total Bachelor Degrees Awarded =	1,401
Total Master's Degrees Awarded =	40

A.S.C. OFFICERS 78-79

PRESIDENT
Dr. James Young, A.I.C.
University of Southern Mississippi

VICE PRESIDENT
George B. LaBaun, A.I.C.
Oregon State University

SECRETARY
Roger Liska, A.I.C.
Auburn

TREASURER
Dr. Robert J. Stone
Temple University

LOCATION OF UPCOMING GENERAL MEETINGS OF A.S.C.

15th — April 1979 — Purdue University
16th — April 1980 — California State Polytechnic University

GENERAL MEMBERSHIP ROSTER — ASSOCIATED SCHOOLS OF CONSTRUCTION

ARIZONA STATE UNIVERSITY
Division of Construction
College of Engineering & Applied Science
Temple, Arizona 85281

AUBURN UNIVERSITY
Department of Building Science
Auburn, Alabama 38630

BOWLING GREEN STATE UNIVERSITY
Industrial Education & Technology
Bowling Green, Ohio 43404

BRADLEY UNIVERSITY
Department of Construction
College of Engineering & Technology
Peoria, Illinois 61606

CALIFORNIA STATE — FRESNO
Department of Industrial Arts & Technology
Fresno, California 93726

CALIFORNIA STATE POLYTECHNIC UNIVERSITY
School of Architecture & Environmental Design
San Luis Obispo, California 93407

CLEMSON UNIVERSITY
Building Science
College of Architecture
Clemson, South Carolina 29631

UNIVERSITY OF COLORADO
Architectural Engineering
Boulder, Colorado 80302

COLORADO STATE UNIVERSITY
Industrial-Construction Management
Department of Industrial Sciences
Fort Collins, Colorado 80523

FAIRLEIGH DICKINSON UNIVERSITY
Department of Engineering Technology
1000 River Road
Teaneck, New Jersey 07666

FLORIDA INTERNATIONAL UNIVERSITY
School of Technology, Construction Department
Tamiami Campus
Miami, Florida 33199

UNIVERSITY OF FLORIDA
School of Building Construction
College of Architecture & Fine Arts
Gainesville, Florida 32611

GEORGIA INSTITUTE OF TECHNOLOGY
College of Architecture
Atlanta, Georgia 30332

UNIVERSITY OF HOUSTON
Department of Civil Technology
Houston, Texas 77044

INDIANA UNIVERSITY — PURDUE UNIVERSITY AT INDIANAPOLIS
Department of Construction Technology
1201 East 38th Street
Indianapolis, Indiana 46205

IOWA STATE UNIVERSITY
Construction Engineering
Ames, Iowa 50010

JACKSON STATE UNIVERSITY
School of Industrial & Technological
1325 J. R. Lynch Street
Jackson, Mississippi 39217

JOHN BROWN UNIVERSITY
Department of Building Construction
Siloam Springs, Arkansas 72761

KANSAS STATE COLLEGE OF PITTSBURG
Building Technology Department
Pittsburg, Kansas 66762

KANSAS STATE UNIVERSITY
Department Arch. Engr. & Constr. Science
College of Engineering
Manhattan, Kansas 66506

KEAN COLLEGE OF NEW JERSEY
Department of Industrial Studies
Union, New Jersey 07083

LOUISIANA STATE UNIVERSITY
Department of Construction
Baton Rouge, Louisiana 70803

LOUISIANA TECH UNIVERSITY
Department of Civil Engineering
Ruston, Louisiana 71272

MEMPHIS STATE UNIVERSITY
Division of Engr. Tech — Construction
Memphis, Tennessee 38152

MICHIGAN STATE UNIVERSITY
Building Construction Program
Dept. of Agricultural Engineering
East Lansing, Michigan 48824

UNIVERSITY OF NEBRASKA
Department of Construction Management
College of Engineering & Technology
Lincoln, Nebraska 68588

STATE UNIVERSITY OF NEW YORK AT SYRACUSE
Wood Products Engineering
Syracuse, New York 13210

UNIVERSITY OF NORTH CAROLINA
Engineering Technology
UNCC Station
Charlotte, North Carolina 28223

NORTHEAST LOUISIANA UNIVERSITY
School of Construction
Monroe, Louisiana 71209

OHIO STATE UNIVERSITY
Department of Civil Engineering
2070 Neil Avenue
Columbus, Ohio 43210

OKLAHOMA STATE UNIVERSITY
School of Technology
Division of Engineering
Stillwater, Oklahoma 74074

OREGON STATE UNIVERSITY
Civil Engineering Department
Corvallis, Oregon 97331

PRATT INSTITUTE
Department of Building Science
School of Professional Studies
Brooklyn, New York 11205

PURDUE UNIVERSITY
Civil Engineering
West Lafayette, Indiana 47907

PURDUE UNIVERSITY
Department of Building Construction & Contracting
School of Technology, SCAA
West Lafayette, Indiana 47907

UNIVERSITY OF SOUTHERN MISSISSIPPI
Department of Construction and Architectural Technology
Southern Station, Box 5137
Hattiesburg, Mississippi 39401

SOUTHWEST MISSOURI STATE COLLEGE
Department of Industrial Education
Springfield, Missouri 65803

SPRING GARDEN COLLEGE
Construction Engineering Technology Department
102 East Mermaid Lane
Chestnut Hill, Pennsylvania 19122

TEMPLE UNIVERSITY
Department of Civil Engineering
College of Engineering Technology
Philadelphia, PA 19122

TEXAS A & M UNIVERSITY
School of Architecture
College Station, Texas 77843

TEXAS A & M UNIVERSITY
College of Engineering
College Station, Texas 77843

VIRGINIA POLYTECHNIC INSTITUTE
Department of Building Construction
College of Architecture
Blacksburg, Virginia 24061

UNIVERSITY OF WASHINGTON
Department of Building Construction
College of Architecture & Urban Planning
Seattle, Washington 98105

WASHINGTON STATE UNIVERSITY
Construction Management
Department of Architecture
Pullman, Washington 99164

WEST VIRGINIA STATE COLLEGE
Department of Industrial Technology
(Building Construction)
Institute, West Virginia 25112

UNIVERSITY OF WISCONSIN—MADISON
Agricultural Engineering Department
460 Henry Mall
Madison, Wisconsin 53706

UNIVERSITY OF WISCONSIN PLATTEVILLE
College of Business, Industry & Communications
Department of Industrial Studies
Platteville, Wisconsin 53818

UNIVERSITY OF WISCONSIN—STOUT
School of Industry & Technology
Menomonie, Wisconsin 54751

APPENDIX G

Young, James W. "Analysis of Construction Curricular Elements." Published Doctor of Education dissertation, University of Northern Colorado, 1977.

Purpose

The purpose of this study was to explore the perceptions of experienced constructors regarding elements of a construction curricular guide recommended by the education committee of the Associated General Contractors in 1967. More specifically, the study was designed to ascertain: (1) the relative level of importance experienced constructors place on each of the elements of the curricular guide; (2) if element instruction should be acquired from sources other than an undergraduate construction program; (3) if constructors identify elements not included in the original guidelines; (4) if academic background and length of construction experience influence the perceptions of constructors toward the construction curricular elements.

Procedures for the Study

An ex post facto design was selected for this study of the perceptions of experienced constructors regarding elements of a construction curricular guide. Participants were limited to field and project management personnel with baccalaureate degrees.

Sixty-three employees of Colorado AGC member firms completed the survey instrument.

To determine the relative importance of each element, the mean and standard deviation was computed and rank ordered. Mean values for level of importance were obtained by equating: "No importance" to 0; "moderate importance" to 1; "substantial importance" to 2; and "essential" to 3. Respondents selected an alternate source of instruction if the element was judged not appropriate to undergraduate instruction.

The influence of academic background on perceptions of element importance was tested by T-test of difference of means. The relationship of academic background to perceptions of element importance with experience controlled was tested by chi-square test of significance.

The data were analyzed with the assistance of the "Statistical Package for the Social Sciences" computer program.

Findings

(1) The influence of academic background on perceptions of respondents was significant on 31 percent of the elements. (2) With experience controlled, the relationship of academic background to perceptions of element importance was significant on only 13 percent of the elements. (3) Respondents attached greater importance to elements closely related to their responsibilities. (4) Only eight

elements were perceived by even a sizeable minority of the respondents as more appropriately acquired from sources other than an undergraduate program. (5) No element received sufficient negative response to exclude the element from the original guidelines for undergraduate construction programs.

Conclusions

Based on the findings of this study, the following conclusions were drawn: (1) Respondents found it difficult to look beyond their own particular job responsibilities in evaluating element importance. (2) Respondents attached a higher level of importance to elements which were related to their academic background. (3) The length of construction experience does not appear to have a significant influence on perceptions of element importance. (4) The response to work experience as an alternate source of instruction for construction oriented elements indicates that classroom instruction for these elements has only partially been accepted by industry personnel. (5) While eight elements were found to be substantially less important than all other elements, the conclusion may be drawn that the original construction education guidelines are essentially as valid now as when they were developed.

Recommendations

It is recommended that: (1) Based on the apparent influence of academic background, construction program advisory committees should be comprised of persons with differing academic backgrounds. (2) The study should be replicated with a population drawn from upper levels of management to determine if their perception of element importance is comparable to perceptions expressed in this study. (3) The role and place of required work experience prior to graduation should be studied. (4) The study should be replicated in differing geographic locations and with construction firms belonging to other industry associations. (5) In light of the minority response to alternate sources of element instruction, the education committee of the AGC should consider development of additional guidelines for inclusion of co-op (or internship) programs in the undergraduate programs, use of industry seminars as supplementary undergraduate instruction, and development of guidelines for graduate level construction courses.

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